9.6
E J
22

RR IN TWO SECTIONS—SECTION ONE

MECHANICAL ENGINEERING

THE LIBRARY OF THE
UNIVERSITY OF ILLINOIS

Shamrock V and Enterprise
Wind is Still the Motive Power but
Modern Engineering Materials Improve the Structure

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

November 1930

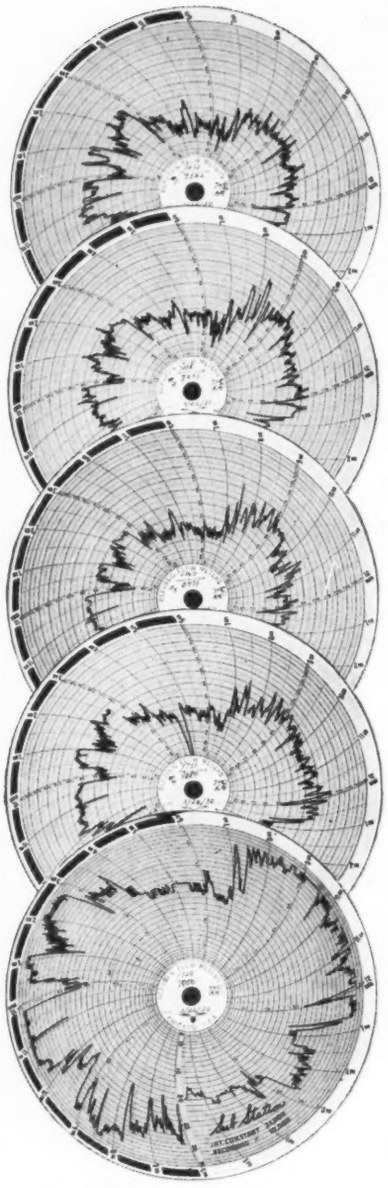


Chart showing the amount of steam used in the steel mill. These show clearly the typical steel mill load with its wide fluctuations. Also they show during the high load period the steam flow was beyond the limit of the steam meter.

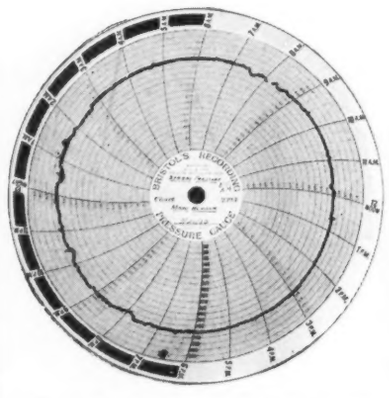
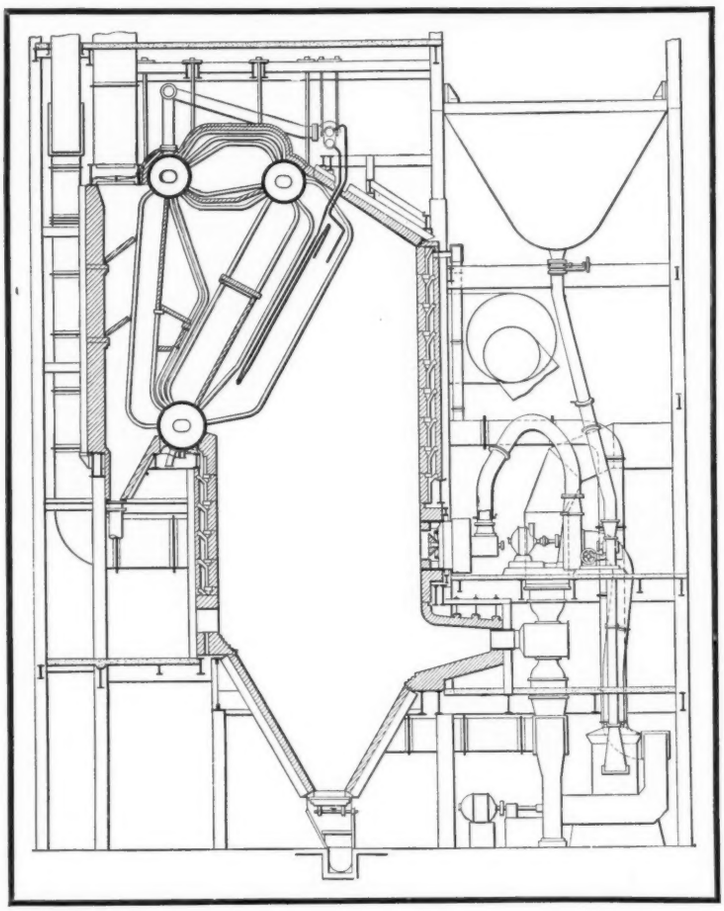


Chart showing how closely the steam pressure has been held regardless of the wide fluctuations in steam flow

RAYMOND ROLLER MILLS

for Direct Fired Units



In the Pittsburgh district a large steel company is operating direct fired pulverized fuel units with Raymond Roller Mills. This combination handles the widely fluctuating steel mill load with surprising ease, as the speed of the mill, the mill exhauster and feeder, are automatically controlled and there is no variation in the fineness of the fuel fed to the furnace.

Combustion Engineering Corporation equipment in this installation includes: 4 three drum Ladd boilers of 14,250 sq. ft. of heating surface each, 4 Lopulco Direct Fired Pulverized Fuel Systems and 2 Raymond 4-ton Roller Mills for each boiler.

COMBUSTION ENGINEERING CORPORATION

200 Madison Avenue - - - - New York, N. Y.

Boilers - Pulverized Fuel Equipment - Stokers
Water-Cooled Furnaces - Air-Preheaters

Mechanical Engineering

The Monthly Journal Published by

The American Society of Mechanical Engineers

Publication Office, 20th and Northampton Streets, Easton, Pa. Editorial and Advertising Departments at the Headquarters of the Society, 29 West Thirty-Ninth Street, New York

Vol. 52 NOVEMBER, 1930, Section One Number 11

CONTENTS OF THIS ISSUE

Products From Fibrous and Granular Wood ... *W. E. Emley* ... 953
The Application of Engineering to the Agricultural Industry ... *Henry Giese* ... 956
Machine-Tool Milestones, Past and Future ... *S. Einstein* ... 959
Decentralized Employee Training ... *W. J. Donald* ... 963
Fluid Metering in Practice ... *Ed S. Smith, Jr.* ... 968
Future Aircraft-Design Trends ... *R. R. Osborn* ... 971
Flying From the Private-Owner's Standpoint ... *Earle Ovington* ... 974
Inland Steel Company's New High-Speed Merchant Mill ... 977
Combustion Radiation and the Planck Quantum Theory (*Continued*) ... *W. J. Wohlenberg* ... 981
How Safe Is a Factor of Safety? ... *J. Dilot* ... 984
Instruments and Apparatus—Part 20—Smoke-Density Determinations ... 999
International Rules and Regulations for Acceptance Tests of Steam Turbines ... 1010
International Congress of Applied Mechanics at Stockholm ... 1012
Metal Week in Chicago ... 1013
List of A.S.M.E. 1930 Annual Meeting Papers Available in Pamphlet Form ... 1020
Program of A.S.M.E. 1930 Annual Meeting ... 1021
Synopses of A.S.M.E. 1930 Annual Meeting Papers ... 1023

DEPARTMENTAL

Survey of Engineering Progress ... 986
A Review of Attainment in Mechanical Engineering and Related Fields

Engineering and Industrial Standardization ... 997
Railroad Standardization Effects Economies in Europe and America; Track Bolts and Nuts; Pipe Flanges and Fittings; Mechanical Standards Advisory Council; New American Standards

Correspondence ... 1001
Scandinavian Gang Saws for Closer Utilization of Timber

The Conference Table ... 1004

Editorial ... 1006
Arctic Discoveries; Extratechnological Progressiveness; Confidence in Aircraft; Photography of Sound; Control of Unemployment; "Civil Engineering;" When a Material Becomes Cheap; Good Out of Russia; "Selling Short;" Daniel Guggenheim

Book Reviews and Library Notes ... 1014
Principles of Engineering Economy; Standard Costs; Ingenious Mechanisms for Designers and Inventors; Books Received in the Library

Synopses of A.S.M.E. Transactions Papers ... 1017

Current Mechanical Engineering Literature ... 1031

ADVERTISING

Display Advertisements ... 1
Classified List of Mechanical Equipment ... 32
Professional Engineering Service Section ... 126
Opportunity Advertisements ... 130
Alphabetical List of Advertisers ... 132

Section Two—News of Mechanical Engineering

Price 60 Cents a Copy, $5.00 a Year; to Members and Affiliates, 50 Cents a Copy, $4.00 a Year. Postage to Canada, 75 Cents Additional; to Foreign Countries, $1.50 Additional. Changes of Address should be sent to the Society Headquarters.

Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on January 17, 1921.

Copyrighted, 1930, by The American Society of Mechanical Engineers

December 1 to 5, 1930

THE monastic phase of engineering is rapidly passing. No longer is the professional engineer content to concern himself solely with the technological aspects of his work. He has found, as did the schoolmen of the Renaissance, that there is greater significance and satisfaction in meeting squarely all of the responsibilities that are implicit in the possession of special knowledge than there is in a monastic insularity that denies them. He is learning that the social and political sciences demand as careful attention in his larger problems as do the physical sciences. Without being less of an engineer, he is becoming a more intelligent citizen. He is contributing not only the machinery of civilization, but also to its control. Engineering journals and engineering societies, reflecting the tendency of the times, are constantly paying more attention to non-technological subjects.

The Fifty-First Annual Meeting of the A.S.M.E., New York, December 1 to 5, provides some of these broadening influences in addition to an extensive program of technical papers and discussions. Dr. Wesley C. Mitchell, Director of Research of the National Bureau of Economic Research, Inc., and Mr. Ralph E. Flanders, Vice-President of the A.S.M.E., will present points of view on the important subject of social and economic control, Prof. Elliott Dunlap Smith, of Yale University, will deliver the address at the Annual Dinner, Wednesday evening, December 3. Professor Smith will speak on the most baffling of all problems, one that faces the engineer constantly and wherever he may be the practical elements of human relations. A third feature of general and unusual interest will be a series of three lectures on public speaking, to be delivered on Tuesday, Wednesday, and Thursday mornings, December 2, 3, and 4, by Prof. S. M. Tucker of the Brooklyn Polytechnic Institute.

Mark December 1 to 5 on your calendar in red letters.

MECHANICAL ENGINEERING

Volume 52 November, 1930 No. 11

Products From Fibrous and Granular Wood[1]

Binders for Sawdust When Used as a Filler—Waste Wood as a Source for Organic Chemicals—Advantageous Properties of Wood—Possibilities Resident in the Utilization of Wood-Cell Cement in Fabricating Monoligneous Structures

By WARREN E. EMLEY,[2] WASHINGTON, D. C.

A CONSIDERABLE market has been developed for sawdust and wood flour to be used as a filler in molded plastics, and the growth of this industry has been so phenomenal as to excite the imagination. The process whereby waste wood is exploded into its ultimate fibers, which can then be recombined into board, has also attracted public attention. However, whether the waste wood is utilized "as is," or ground to wood flour, or separated into its constituent fibers, it still may be considered as performing the rôle of a filler, to which some binders must be added to produce a useful product.

Example of Cement Industry

The extensive research work which has been conducted by the portland-cement industry may be drawn upon to get a clear picture of the problems involved. They have learned that the properties of concrete are controlled by four basic factors: the nature of the binder (cement and water), the nature of the filler (sand, gravel, etc.), the relative proportions of the two, and the character of the workmanship used in making the concrete. When the cement industry has available complete information about the effects of these factors, it will then be possible to design the best concrete for a given purpose, within the limitations of the physical properties of the materials used.

In the foregoing case, the properties of the binder can be varied within only narrow limits, but the selection of the filler is based upon the economic balance between what the consumer wants and what he is willing to pay for. In the utilization of waste wood, the situation is exactly reversed; the properties of the filler are practically fixed, but there is great latitude permitted in selecting the binder.

In any given case, the binder to be selected is the one giving a product which will have the properties desired by the consumer, or the consumer may find it expedient to sacrifice some of his desires in order to get a cheaper product.

Function of a Binder

There is a great variety of binders known, and many of them are in every-day use. In the inorganic field, there are those which harden by mere drying, such as clay; those which harden by cooling, like sulphur; those which react chemically with the air, like lime, or with water, like cement. These classes are represented in the organic field by materials such as shellac, asphalt, linseed oil, etc. Another class is composed of materials which harden by polymerization. Then there are many binders which are mixtures of two materials which combine chemically with each other, the reaction being more or less controllable by the operator. Dental cement is a familiar inorganic example of this class, to which a great group of organic synthetic resins also belong. It is too much to expect that all of the important properties of all of these thousands of binders can be found in the literature, but at least enough information is available to enable one to make an intelligent start.

Relation of Binder and Filler

The problem of utilizing waste wood as a filler is not properly named. In fact, this way of stating it shows a diametrically wrong viewpoint. The problem should be stated, "How can I make a certain product (which must be specifically described), using waste wood as a filler?"

If the product is thick, binders which harden by drying can be eliminated from further consideration; the shrinkage and the time consumed in drying will probably make their use impracticable. If the product must be machined, certain other binders are ruled out as too brittle to be of use. If the product must be proof against alkali, another large group of binders is unsuitable. And so on through the list of the important properties of the finished product. If the requirements are very exacting, there will probably be only a few binders left as worthy of further consideration. This number may be still further reduced by limitations due to the method of use. A binder which requires a very high temperature during its manipulation is obviously not suitable for use with waste wood. Finally, the few binders which have met all of these requirements should be put into the laboratory and the products be made. It will probably be found

---

[1] Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

[2] Chief, Organic and Fibrous Materials Division, Bureau of Standards. Mr. Emley received his B.S. from the University of Michigan, 1906, and Ch.E., University of Michigan, 1912. He has been chemist, Fletcher Paper Company, Alpena, Mich., 1906–08; chemist, Bureau of Standards, Pittsburgh, Pa., 1909–17; assistant to the president of the Riverton Lime Company, Riverton, Va., 1917–18; chief, Lime Section, Bureau of Standards, Washington, D. C., 1918–26; chief, Division of Organic and Fibrous Materials, Bureau of Standards, Washington, D. C., 1926 to date. He is a member of the American Institute of Chemical Engineers.

Presented at the Fifth National Wood Industries Meeting, New York, N. Y., Oct. 16 and 17, 1930, of The American Society of Mechanical Engineers.

that each of the binders produces a result which is more or less satisfactory. Then is the time to balance the quality of the product against the cost.

Research Methods of Bureau of Standards

Since this method of conducting research is somewhat unusual, it may be of interest to present a time analysis of a similar project just now being completed at the Bureau of Standards.

Selection of the product to be made required no time on our part, since the work was undertaken at the request of the consumer. We were also furnished complete information as to the relative importance of the different properties of the product, and data as to the methods of measuring them and the numerical values desired. In the usual case, it is safe to estimate that these three steps will require several months, and, if appropriate test methods are not available, may take years. Then about one man-year was spent in reading and digesting the literature. The time for this operation will of course be materially reduced for the next project, but new binders are being invented so rapidly that a considerable amount of time will be necessary to bring the digest up to date whenever a new project is undertaken. About six months were spent in laboratory work, measuring certain properties of binders which could not be found described in the literature. With the information available, it did not take long to decide that one particular binder (in this case cellulose xanthate) showed outstanding promise. A few weeks' laboratory work demonstrated the applicability of this binder, and the project has now passed to the final test of actual service, which will require some years.

The foregoing project has been detailed at such length to emphasize one fact: any such project must be built around the product to be made. To find a satisfactory binder for waste wood is too indefinite a problem. To find a binder which can be used with waste wood to make a given product is a problem which, within reason, can probably be solved, but each product involves a separate piece of research.

Wood Waste as a Filler

The title assigned this paper presents an opportunity to urge the consideration of waste wood as a material which may have some value other than as a filler.

The work done by the portland-cement industry, the tire industry, and many others has proved that a filler is an important and frequently indispensable ingredient. But in spite of this, the term "filler" popularly connotes something to cheapen or adulterate the product. Waste wood to be used as a filler must compete directly with many other agricultural wastes, such as cotton burs, corncobs, oat hulls, etc., and the competition must in general be based upon price rather than quality. Such a situation is not attractive, and to limit the discussion to this use would indicate a lack of imagination.

Organic Chemicals

Consider waste wood as a source of organic chemicals. In a recent manufacturer's catalog there are listed 25 organic chemicals which are quoted in carload lots, all of which were museum curiosities 20 years ago, and all of them are made up of the same three elements, carbon, hydrogen, and oxygen, of which wood is composed—just arranged a little differently.

Formerly wood alcohol was made by the destructive distillation of wood; now it is being made synthetically from coal and water. Nature takes years of time and great quantities of energy to collect carbon, hydrogen, and oxygen from the air and the soil and make a tree. Then she spends much more time and energy breaking down her product, driving off the hydrogen and oxygen, perhaps in the form of water, leaving the carbon in the ground as coal. Then man, by a devious process involving the expenditure of much more energy, makes the hydrogen and oxygen recombine with carbon of the coal, and produces wood alcohol. From the economic viewpoint, this process appears to be as prodigally wasteful as only nature can afford to be.

Dr. Bergius has recently perfected his process for making glucose from wood cellulose. More recently, Dr. Hibbert has announced the possibility of reversing the process; making cellulose from glucose. Man is thus beginning to learn how to rearrange the carbon, hydrogen, and oxygen found in wood into combinations better suited to his immediate needs.

The sad business experience which the wood-alcohol industry has recently gone through is frequently taken as proof that wood alcohol from wood cannot compete with wood alcohol from coal. This conclusion is not justified. The correct conclusion is that the destructive-distillation process is incompatible with the present economic situation. Considering the time and energy required to make wood alcohol from coal, there must, in all probability, be some way to make it more cheaply from wood, but this way is not by destructive distillation.

Elements of Wood

Before trying to find out how to rearrange the elements of wood, it might be well to learn how they are at present arranged. Wood is usually spoken of as containing cellulose, lignin, pentosan, etc. All of these terms are used loosely, and have rather indefinite meanings. Cellulose is the constituent which has been most carefully studied, but the fundamental difference between the three varieties, alpha, beta, and gamma, is still unknown, nor is it certain that cellulose from spruce is the same as cellulose from cotton. The composition, or rather the definition, of lignin is just beginning to be seriously studied. The attempt by the Bureau of Standards to make the sugar xylose from the pentosan content of cellulosic materials has recently been brought to a successful conclusion on a semi-commercial scale.

Program Recommended

The ambitious program urged for consideration is therefore:

1 Ascertain what are the chemical compounds existing in wood.

2 Learn how the three elements, carbon, hydrogen, and oxygen, are arranged in each compound.

3 Learn how to rearrange these elements to produce compounds presently marketable.

It is recognized that all of the chemists in the country could be employed for the next generation on this program. But the work can be done piecemeal, and the results will be proportional to the efforts expended.

Of course, the logical solution of the waste-wood problem is to prevent the formation of waste wood rather than to find a means of using it.

Plasticity of Wood

Within the usual definitions of the term, wood is not a plastic material. Since, however, it is essentially a collection of unit cells in a matrix of lignified material, may it not be possible, with thorough access of treatment material, to render this matrix temporarily plastic and make it possible to bend or shape wood readily and permanently into useful form, or even by the exercise of internal or external pressures to give it a lighter or denser structure consistent with specific purposes for which its use may be desirable?

Wood Impregnation

Since any treatment effected must be substantially uniform through considerable thicknesses of the material, one of the greatest treatment problems is that of getting the material or

agent employed into the wood and then getting the vehicle or solvent, if any is used, out of the wood. Treatment practice to date has been none too successful in this respect, especially with certain types of hardwoods and with the heartwood of most species.

The penetration of such resistant materials by treatment agencies is essentially a capillary process through infinitesimal openings or channels, assisted to some extent by pressure and vacuum, but much restricted by the relatively small area of openings as compared to the total of cell walls in the material. To speed up penetration and improve its uniformity, some method must be devised to break down the pith membranes in which these openings occur. This would not seriously damage the structural value of the material and would tremendously increase the rate of penetration. Perhaps it can be done by partial saturation with one or another liquid and subsequent exposure to sudden cold. Perhaps it can be done by saturation with gas under high pressures and subsequent quickly reduced pressure. Perhaps some gas can be found which by weakening the structure of the pith membranes will leave them open to fracture by subsequent pressure of treatment material. Perhaps some other method will be found entirely foreign to these suggested. In some way or other the desired results must be accomplished before treatment methods can be satisfactorily effected.

Assume for the moment that this can be done. Impregnation with relatively small amounts of toxic materials, sufficient, however, to secure complete protection from decay and insect attack, becomes immediately feasible. Wood so treated can be fabricated in the process of installation, and, except for weathering and abrasion or attack of fire, becomes one of the most permanent of materials.

Wood Strength

Wood apparently owes its strength in compression or tension to the strength of minute structural shapes made up of more or less lignified junctions of three or more cells, and to the properties of the lignin which cause these cells to act in common in resisting stress. Looking at it in another way, the strength of wood inheres in the structural value of the walls of each cell, the cells acting as tubes and failing by buckling or direct tension of the cell wall. Lignin varies considerably as between different species. Its chemical make-up is not well known. Extracted from the wood, it is possible to alter and improve the structural qualities of lignin. Can it not, therefore, be improved in the wood, assuming free access of treatment materials, and the core or web of these structural members made up by continuous cells correspondingly improved in strength? Possibly subjecting the moist wood to the action of heat and pressure does develop a lignin binder.

A cylinder filled with solid material has greater total strength in compression than an empty cylinder. May it not be possible by filling the cells of wood with inert materials to greatly increase its structural strength in compression, perpendicular and parallel to the grain? This is, in fact, accomplished by treatment with molten sulphur, though at the sacrifice of certain other desirable characteristics. There are indications that the strength of individual wood cells is due in part to the arrangement of molecules in their structure and to the character of the cellulose molecules themselves. Assuming these are to some extent unsatisfied combinations of atoms, may it not be possible by suitable treatment to increase their volume, and with it the thickness and strength of the cell wall, without materially altering the wood structure?

Combustibility of Wood

One of the greatest objections to wood is its combustibility, this objection inhering not so much in the fact that it breaks down under attack of ordinary fire temperatures, since practically all materials suffer a change of chemical or physical characteristics under similar conditions, but because in breaking down it liberates sufficient heat to support its own combustion and contributes liberally to the total of heat exposure in which it may be involved. On a small scale and more or less laboriously and expensively, wood is being treated to avoid both these objectionable characteristics. With ready penetration of the material by treatment chemicals, the process should be so expedited and cheapened as to make it commercially feasible to apply to a large portion of the wood used in building construction, furniture, and for miscellaneous equipment purposes, thereby greatly extending its field of use in proportion to present-day practice.

Hardness of Wood—Moisture Absorption

Substantially the same situation obtains as regards increase in the hardness of wood for flooring and other purposes where abrasion resistance is a primary consideration. This can be and is done on a considerable scale in the laboratory, but requires more ready penetration of the wood by treatment processes to make it commercially feasible.

The moisture-absorptive properties of wood and its consequent swelling and shrinkage with moisture-content changes probably constitute its greatest genuine objection from many use viewpoints. Much is known about the behavior of water present in the wood with reference to its chemical and physical make-up. Much still remains to be learned, and there are indications that when this further knowledge is available there will be developed means both of retarding or preventing moisture absorption and of restricting the consequent volume changes in the material. The possibilities of moisture exclusion in increasing strength, toughness, hardness, and in preventing such contingencies as decay, shrinkage, swelling, glue failures, warping, weathering, etc., are tremendously important from a wood-use viewpoint.

Lignin as an Adhesive or Binder

Returning for a moment to the subject of lignin, this constitutes the glue by which the component cells of the wood structure are attached to each other. It is quite conceivable that by extracting and treating this lignin in fashions to be determined when its chemical composition is better known, it can be made a permanently effective glue for attaching one piece of wood to another. It might be possible, therefore, to build up either large structural members or wide shapes from relatively small pieces of wood, or to improve the shear properties of wood in structural framing details, or even bring about a new era in such uses as airplane-frame construction, furniture, and fine millwork by which the component parts of the particle become one common piece of material. With such a glue the possibilities of plywood construction, involving high-grade materials for surface purposes and low-grade materials for interior layers, might be greatly extended.

The author wishes to express his appreciation to Mr. Frank Cartwright, engineer of the National Lumber Manufacturers' Association, for several of the ideas suggested. It may be worth while to call attention to one of the differences between pure and applied research. If applied research is defined as having an immediate financial return in view, individuals frequently find it advisable to conduct such work at their own expense and under their own control. Pure research, or the development of information necessary for the future growth of an industry, should be supported by the widest possible cooperation in order that the results may be available to all people. The Bureau of Standards is always ready, to the limit of its ability, to enter into any such plan for cooperative work within its field.

The Application of Engineering to the Agricultural Industry

By HENRY GIESE,[1] AMES, IOWA

IN A recent discussion of trends in business, Merle Thorpe, editor of *Nation's Business*, said that the first quarter of the twentieth century would probably be known as the age of mass production.

With the great industrial developments so immediately before our eyes it seems unnecessary to make further mention of them here. Rather it is our intention to speak regarding the progress which has been made in the agricultural field and the obligation of the engineer in helping it to keep pace with other enterprises. William M. Jardine, former Secretary of Agriculture, once said: "Could the farmer of the Pharaohs' time have been suddenly reincarnated and set down in our grandfather's wheat field, he could have picked up the grain cradle and gone to work with a familiar tool at a perfectly familiar job." Imagine the amazement of the ancient Egyptian if he were to be set down in a present-day wheat field with the combined harvester-thresher in full operation.

Less than a century ago more than 90 per cent of our total population were directly dependent upon agriculture for a livelihood. In 1928, with fewer than 24 per cent directly dependent upon the industry, our nation produced a surplus of agricultural commodities. American agriculture may be said to have had three power epochs: (1) human, (2) animal, (3) mechanical. The change has brought not only a more efficient production but also a relief from the drudgery and monotony which doubtless contributed to the encouragement of slavery.

Mechanization of agriculture has made the American farmer the most efficient farmer in the world. According to data compiled by the division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture, the estimated total primary horsepower available on farms increased from approximately seven millions in 1850 to nearly 47½ millions in 1924. The direct relationship between power used and the value of crops produced is strikingly shown in the table[2] at the top of the next column.

According to Davidson,[3] the United States exports rice in increasing amount to China. Here we have the extreme in contrasts; rice production in China by hand labor at a low wage, fifteen cents a day, and rice production in California by machine methods with the highest-priced agricultural labor in the country, or fifty to sixty cents an hour with "found." The Chinese laborer boards himself. Is it reasonable to believe that engineering will continue to contribute to the progress and development of agriculture? Engineering more than any other factor has enabled the American farmer to compete with foreign competitors. A few years ago several German scientists visited this country, and the outstanding feature of their report on American agriculture was the large production per worker.

Country or state	Primary horsepower per agricultural worker	Value of crops produced annually
Italy	0.19	$ 45
France	0.37	90
Germany	0.55	119
United Kingdom	0.88	126
Alabama	0.81	112
New York	1.69	250
Indiana	2.46	365
Iowa	3.86	595
Nebraska	4.71	910

Nevertheless, the increased production per worker in agriculture has not kept pace with that in many of the other industries, and the return to the individual worker has been a problem which has received the serious attention of our federal government. In the final analysis, the returns per worker are of greatest importance in establishing a stabilized situation. The American Farm Bureau Federation has adopted the slogan, "A higher standard of living on the farm, and an income from the farm to pay the bill."

Davidson has expressed the relationship by the simple equation, $I = (S - C)\,Q$, in which I signifies the income, S the selling, and C the cost price of the farm produce, and Q the quantity produced. Obviously, I can be increased by increasing S or Q or by decreasing C. S is difficult to control, especially when agricultural products are produced on some six million farms. Competition is severe in agriculture since we have not only the competition of individuals in our own country but also a stimulation of production in other countries. Prices raised by legislative action are likely to be short-lived as a relief measure. Increased prices are always followed by increased production and land prices. Increased production usually leads to overproduction, a glutted market, and falling prices.

An increase in the efficiency of production probably offers one of the most encouraging possibilities of increasing the income of the individual. This through the decrease of C or the increase of Q in the formula becomes, or may become, very largely a problem for the agricultural engineer.

The primary function of the agricultural engineer is to determine, recommend, and promote the best solutions of engineering problems peculiar to the agricultural industries. His responsibility is—through modern operating equipment and practices—to aid in developing higher efficiency and greater productive capacity, thus making agriculture more profitable, lifting the burden of drudgery from agricultural people and raising their standard of living. Recognizing this, the American Society of Agricultural Engineers, as the national organization representing the agricultural engineering profession, has adopted the following platform as a statement of its objectives and of the principles and policies governing its activities.

---

[1] Senior Agricultural Engineer, Division of Agricultural Engineering, U. S. Bureau of Public Roads. Mr. Giese was graduated from Iowa State College in 1919 with the degree of B.S. in Architectural Engineering, later receiving his M.S. in Agricultural Engineering (1927), and the degree of Architectural Engineer (1930). Since graduation he has successively taught mathematics and agricultural engineering at Iowa State College, and now occupies a chair of the latter science. His service with the Bureau of Public Roads has taken place while on leave from June, 1929, to the beginning of the present school year.

[2] From Bul. 1348—U. S. Department of Agriculture, p. 17.

[3] J. B. Davidson, "Agricultural Engineering," *Journal of Engineering Education*, New Series, vol xix, no. 3, November, 1928.

Paper read before Section M—Engineering, American Association for the Advancement of Science, Des Moines, Iowa, Dec. 30, 1929.

" 'Engineering is the science of controlling the forces and utilizing the materials of nature for the benefit of man, and the art of organizing and directing human activities in connection therewith.' Agricultural engineering deals with the application of the fundamental branches of engineering to the specific conditions and requirements of agriculture as an industry, as a mode of life and as a field of applied science. Subdivided on the basis of engineering technique, it now embraces (1) power and machinery, including rural electrification, (2) buildings and other structures, including sanitation, materials of construction, and equipment, and (3) land reclamation, including irrigation, drainage, soil-erosion control, and other forms of mechanical improvement of agricultural lands.

"An agricultural engineer is one who has been trained in both engineering and agriculture, with experience in combining the two, and who is qualified to develop, design, organize, and direct engineering work of, or closely related to, the agricultural industries.

"Agricultural engineering is fostered by land-grant institutions. Thirty-seven of forty-eight agricultural colleges in the United States provide agricultural-engineering training to five thousand agricultural students annually. Technical engineers for this field are trained in seventeen of these institutions. Research work in this field is conducted by 103 full-time workers in thirty-four institutions."

FARM STRUCTURES

According to the latest census figures, the American farmer maintains a total investment in farm buildings of $11,750,000,000. How much it would cost to replace these buildings at the present time would be difficult even to guess. In order to maintain the buildings which he deems necessary for his farm, he spends several millions of dollars every day of the year. Unfortunately this money is often not well spent. Materials are frequently used where they are not at all suited, and sufficient consideration is not given to the actual requirements of the product housed.

With the recent agricultural depression the soundness of the farmers' investment has been seriously questioned, and since buildings appear to afford the easiest method of reducing his overhead, those in position to advise may have been guilty of preaching false economies in building construction. How many times has he been urged to reduce the cost of his buildings without due regard to the effect which this reduction might have on production or annual depreciation?

Industry buys equipment on a production-cost basis. The ability of a given machine to bring returns is just as important a consideration as its original cost. A seemingly cheap machine may prove to be very expensive when its influence on production labor, length of productive life, and other factors are considered. Farm buildings constitute a part of the farmer's working equipment and deserve to be evaluated upon a production-cost basis. The cost per quart of milk is more important than the cost per cow or the cost per barn. This attitude does not infer that we should neglect beauty or harmony in design, which have a very direct bearing upon morale, but that the emphasis should be put upon the securing of lower production costs by giving attention to management and fundamental housing requirements. The manner in which the farm-building problem is handled is reflected in labor of operation, the quantity and quality of production, and, in the case of stored products, in the preservation for future needs.

One of the serious problems for farm management is that of labor. I am told that this is particularly true in the dairy industry. Recent studies show that the labor involved in dairying may be increased upward of 30 per cent by faulty arrangement of the barn and its relation to the other buildings on the farmstead. Fortunately it costs no more to arrange a barn efficiently. Often the saving in labor alone may be as large as the entire charge which may be placed against the dairy cow for rental.

If one expects to make dairying profitable, can he afford to neglect to plan the layout of his farmstead to assure efficiency in the use of labor?

The dairy cow is a warm-blooded animal. She may be likened to an engine operating under a fairly constant temperature. Fuel burned within the body generates heat, which tends to raise the body temperature. She is provided with certain automatic means which dissipate this heat in order to keep the body temperature constant. Heat is radiated from the body surfaces. Moisture evaporated from the skin and thrown off by respiration carried off relatively large quantities of heat and helps keep the body temperature down. The rate at which this process goes on depends very largely upon the environmental conditions of air temperature, relative humidity, and rate of air movement. If the combined effect is greater than the normal heat production of the body, more fuel must be consumed or body tissues destroyed to maintain comfort.

Experienced dairymen say that stable temperatures affect milk flow, and that a cold spell may reduce the production by 5 per cent or more. This reduction is frequently not temporary but continues throughout the current lactation period. Heavy feeding may prevent this reduction, but it is in itself an additional expense.

When it is considered that the total charge against the cow for housing is usually less than 10 per cent of the total cost of producing milk, it may readily be seen that any attempt to reduce the cost of barn construction below the point where it satisfies the housing requirements may increase other cost factors more than is saved in building.

One might elaborate to show how buildings may affect returns in other lines. Egg production reflects the comfort of the birds. Grains are matured and preserved, horticultural products are kept in prime condition and the marketing period materially extended by proper housing. Whether it be housing live stock, grains, fruits, or vegetables, there are definite requirements placed upon the building by the product itself which must be met if the building is to fulfil its obligation to the farmer. In general, these problems relate to the efficiency of operation, the maintenance of effective production, and the preservation or conservation of farm products.

Unfortunately, many of the fundamental housing requirements are not definitely understood. The importance of the building has not been fully appreciated. The small, scattered units have not attracted sufficient competent study. The comparatively long life of the buildings tends to minimize interest in the study of the problem.

Buildings are frequently constructed of materials produced on the farm or purchased in a semi-fabricated condition. More careful attention is then required than would be necessary in the case of machinery which has been manufactured and assembled by specialists and comes to the farmer all ready for operation. If the farm housing problem is to be solved in a way that will bring commensurate returns and constitute an investment rather than a liability, it is necessary that there should be a careful analysis of building methods.

The three major factors of design, construction, and maintenance claim our attention. Utility being paramount, we should know definitely the requirements placed upon the building by the products housed. What environmental conditions does the dairy cow need in order to produce milk most efficiently? How can we house the hen so that she will lay eggs when egg prices are favorable? Is ventilation necessary, and if so, how can it best

be accomplished? What are the sanitary requirements for producing clean milk and maintaining a healthy herd? What insulation is advisable? How can the building be constructed most effectively and economically?

While it may be difficult to put a cash value upon beauty and harmony, they are very important items in maintaining a wholesome atmosphere on the farm. How can the farmstead be made attractive without adding unduly to the cost?

Methods of construction should be carefully studied in order to obtain a building which will provide these requirements at a minimum cost.

The influence of destructive agencies must be understood if we are to build in a way which will lower the depreciation cost.

Since little information is now available, the solution of these questions calls for an extensive research program. Evidently the farmer as an individual cannot conduct his own researches efficiently. The small units and scattered field have not been generally profitable to the architect, and the farmer will not usually employ professional service. A program of this kind is logically the responsibility of publicly supported agencies such as the land-grant colleges and the U. S. Department of Agriculture.

Power and Machinery

The agricultural industry is a tremendous user of power. However, the nearly 50,000,000 horsepower available is not being utilized to its greatest efficiency. Engineering attention is necessary if we are to secure lower production costs through the more economical use of power. Farm-equipment design and the mechanization of farm operations now done by hand offer possibilities which challenge the best effort. There has been great progress in the harvesting machinery, but much still remains to be done. The use of electricity as an agricultural power has gained considerable prominence recently. Much investigational work is now being conducted to find the most practical methods of using electrical equipment.

Land Reclamation

The agricultural engineer is interested in the improvement of land in so far as such improvement leads to lower cost of production. At the present time this means chiefly the improvement of land already being cultivated. Often economical cultivation is prevented by wet spots, open ditches, stumps, or other conditions that prevent effective tillage or occupy land that otherwise could be cultivated.

Five types of problems are included: protection against stream overflow, drainage of wet land, irrigation of dry land, control of soil erosion, and clearing of land obstructed by stumps or stones.

The agricultural engineer, as the term implies, is active primarily in the engineering relationships of agriculture. That engineering has had a profound and far-reaching influence on many of the developments in agriculture, especially during the past twenty years, is widely recognized. Engineering has been responsible, in a large measure, for creating a situation in agriculture comparable to that in manufacturing fifty years ago, when great industrial development in America had its real beginning. The evolution now going on in the agricultural industries emphasizes the importance of the engineering relationships and the increasing engineering responsibilities. The American Society of Agricultural Engineers therefore has pledged its activities to the further development and strengthening of the engineering relationships in agriculture, and to the adaptation of the science and art of engineering to agriculture, to the end that the people engaged in farming may have increasingly better means for achieving a more stable prosperity and higher standards of living.

Industrial Magnesium

MAGNESIUM'S history is in some ways similar to aluminum. It has long been known but has only recently become a member of the family of industrial metals. This year is the hundredth anniversary of the preparation of magnesium metal, and the history of its compounds goes back even further, for Epsom salts or magnesium sulphate was discovered in the water of the springs at Epsom, England, in 1695. The medicinal value of these waters led to the discovery of the salt possessing these properties.

In 1852 Bunsen obtained magnesium metal by electrolyzing the fused chloride and this method of procedure is still the basis for its manufacture.

When magnesium metal was first made, electric power was not available in quantity and at a low price. Today, the development of electrical engineering has enabled us to obtain unlimited electric power at a low cost. The cost of the metal has fallen from $5 a pound in 1915 to 57 cents in 1929. Today the purity of the metal from the cells is 99.9 per cent and sometimes reaches 99.95 per cent. The decrease in price has caused an increase in consumption from 50,000 lb. in 1921 to an estimated 900,000 lb. in 1929.

There are many compounds of magnesium known, but only magnesium chloride can, at present, be considered as a magnesium ore. Fortunately, this is one of the most abundant of magnesium compounds.

Magnesium chloride differs from the ores of all other engineering metals in being water soluble and in being obtained as an aqueous solution. Its properties are very similar to those of common salt.

The first step in manufacturing magnesium is a complex fractional crystallization to separate a pure magnesium chloride from all other salts. The next step is removing the water. Heating in hydrochloric acid gas prevents the decomposition that would otherwise take place on heating, and makes magnesium metal possible. The dry magnesium chloride is melted and electrolyzed to give the metal, which floats on the bath of fused salts.

There are four main uses of magnesium metal and many smaller ones. When magnesium metal burns, an intense white light is given out. This is the basis for the use of magnesium in flashlight powder, fireworks, and illumination bombs, a use that has caused many to consider magnesium combustible. However, it is combustible only when powdered or in the form of wire or ribbon.

The second use is in organic syntheses, where magnesium makes possible the preparation of many substances otherwise difficult or impossible to produce.

The third use is as a deoxidant in metallurgy, particularly in the nickel and nickel-alloy industry.

The fourth use is as an engineering metal. Magnesium is mainly used in engineering in the form of its alloys, particularly Dowmetal. These are the lightest structural metals available for engineering purposes; for example, if we take the weight of a unit volume of Dowmetal as 1, aluminum would be 1.6 and steel 4.4. On an area basis it is about $^2/_3$ as strong as steel, but on a weight basis it has three times the tensile strength.

The metal may be cast, forged, or extruded, and is easily welded and machined. Scrap may be recovered by melting in flux and the recovered metal is identical with new metal, since the flux removes all impurities. It is as resistant to atmospheric corrosion as any engineering metal, and is less easily corroded than steel. Its strength does not decrease with age due to absence of intercrystalline corrosion and season cracking.—Abridgment of article in the Industrial Bulletin of Arthur D. Little, Inc., No. 45, September, 1930.

Machine-Tool Milestones, Past and Future

Machine Tools of the Future to Be Heavier, More Rigid, and More Powerful in Cutting Capacity—Welding May Supersede Certain Machining Operations

By S. EINSTEIN,[1] CINCINNATI, OHIO

A FEW MONTHS ago, at the Second World Power Congress, the tremendous developments and the large influence of power on the world's industrial, economic, and social life were reviewed, and justly we were told that power is one of the pillars of modern civilization. The old treadmill, the windmill, the primitive waterwheel, and James Watt's steam engine were contrasted with the modern gas engine, the Diesel engine, the water turbine, and the turbo-generator. A wonderful accomplishment, indeed; but an accomplishment which would have been impossible had not other branches of human endeavor given to the power engineer the tools and the materials to bring his new ideas into practical form.

Let us picture before our mind the difficulties which arose when James Watt wanted to build his first steam engine some 150 years ago. The boring machine for boring the cylinder consisted of a boring bar supported only at one end and which carried a boring cutter of the same size as the bore of the cylinder. It was impossible even with the tolerances then required to bore out such a cylinder, until Wilkinson designed a boring machine which supported the boring bar at both ends, and thus gave a fairly accurate cylinder. Boulton, Watt's partner, wrote that "Mr. Wilkinson has bored us several cylinders almost without error. That of 50 inches diameter which we have put up at Tipton does not err the thickness of an old shilling in any part."

It required a Wilkinson to make Watt's theoretical steam engine a practical success; it requires tens of thousands of Wilkinsons who through their ingenuity shape into iron and steel the tools which make possible the practical application of the principles of the modern small or large power plants. The Wilkinson in Watt's days was admired for producing a cylinder bore within a tolerance of one-thirty-second of an inch. From the Wilkinson of today tolerances of a thousandth of an inch, and even as small as a tenth of a thousandth, are daily expected. For the Wilkinson of Watt's days the relatively accurate production of an article was the main problem. The Wilkinson of today must add to this the commercial or economic problem—that is, to produce the article in the minimum of time and at a minimum of cost.

The modern machine tool, "the Master Tool of Industry," as Dean Kimball calls it, supplies the means for working metals accurately and economically. Many definitions for the term "machine tool" have been advanced, none of which has been acceptable to the industries at large. So instead of attempting to add another explanation to the existing list, let us see what are the primary elements of a machine tool. Briefly expressed, they are:

1 Structural or frame elements whose function it is to carry or support work and tool.

2 Transmission elements which give the work or tool, or both, movements for shaping the work to be produced.

3 Control elements for both adjusting the structural elements relatively to each other and controlling the function of the transmissions for moving either tool or work or both.

It is a known fact that, once a machine tool has been conceived or invented, the structural or frame elements undergo very little or no functional change at all. If one takes Roberts' planer built in 1817, he finds that it has a bed with a table reciprocating on it, and two housings which carry the rail and tool holders. A modern planer is structurally not different from this first planer, although of course it is made heavier, more rigid, and strengthening elements have been added. A revolutionary change has been made, however, in the transmission elements and the control elements of this type of machine. On the Roberts planer there is found an endless chain going over two sheaves, and winding on a drum which is manually rotated in both directions by a large pilot wheel, thus moving the table forward and backward under the tool holders. A modern planer with its direct-coupled reversible electric motor, with its massive and accurately finished gear transmission, illustrates this development. The centralized control of starting reversing, and stopping of the table movement, the feeding mechanism of the tools, and the clamping of the tool holders and rail, illustrate the development of handiness of operation of this modern machine tool. Thus it is seen, and it is true for practically every modern machine tool, that when a machine in its elements has been once conceived, very little or no change whatever takes place in the function of its structural elements. A tremendous amount of ingenuity and development has taken place, however, in what may be termed the transmission means for machine tools and the control elements of machine tools.

One is tempted to give a brief history of the various types of standard machine tools, such as lathes, planers, boring machines, shapers, millers, grinders, etc., to prove that their developments were similar to that of the planer just described. When one now speaks of milestones in machine-tool development, he has particularly in mind certain phases of developments which are common to all machine tools and not to any particular type. Thus it is found that probably the biggest step in the development of modern machine tools was from the hand-driven machine, such as the Roberts planer just described, to the power-driven tool.

It was a slow process indeed, and all know that even toward the end of the last century a number of machine tools were still in use with hand- or foot-power drive. It is safe to say that these machines have at the present time completely disappeared from the industrial field. As far back as 1818 there

---

[1] Chief Engineer, Cincinnati Milling Machine Co. Mem. A.S.M.E. Mr. Einstein has been connected with the Cincinnati Milling Machine Co. since 1904, having held various positions in their engineering department. Since 1920 Mr. Einstein has been Chief Engineer for the company. He was educated at the Technical University at Darmstadt and came to this country in 1903.

Presented at the French Lick Meeting, French Lick, Ind., Oct. 13 to 15, 1930, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

were driving cones on various machine tools driven from countershafts or lineshafts. These cone pulleys, for driving and feeding the work or the tool at different rates, were the controlling variable-speed transmission elements almost up to the beginning of this century. In their design they naturally varied somewhat to suit the particular requirements of the machine tool. There was also a certain lack of power in these transmission drives, inasmuch as the widths of the belts and the diameters of the pulleys were limited by certain conditions. To overcome these difficulties, back gears were added, which naturally gave to the machine greater power and a greater variety of speeds or feeds. Thus in machine tools now there is a highly organized and well-developed variable-speed and feed-change transmission.

The changing from one rate of speed to another required a certain skill of the operator or a shutting down of the machine for shifting the belts. There was also the possibility of slippage of the belt, which, for certain operations, was undesirable or destructive to the work or the tool. In the years following, as industry progressed, the productivity of a machine tool became one of the important factors in the industrial development. To increase this productivity it was necessary to increase the cutting capacity of the machine. The cone drive had certain fundamental weaknesses, transmitting the least amount of power to the spindle when a maximum was desirable—namely, at slow speeds. The same was true with the cone-driven variable-feed transmission. Thus toward the end of the last century there came the development of positive-gear-driven feed-change mechanisms, which not only enabled the use of feeds within the capacity of the machine, but which also gave a constant predetermined rate of traverse and the possibility of quickly changing from one rate of feed to another.

Meanwhile high-speed steel had appeared on the market, which revolutionized the machine-tool industry. Cutting speeds of the various tools could materially be increased with this new material, and at the same time higher rates of traverse of tool or work could be used. This resulted in the development of the so-called single-pulley machine which adopted the positive-gear-change mechanism of the feedbox and used it for the drive of the machine. These new types of machines, heavier in structure, with a positive drive to the work and the tool, successfully took up the battle with high-speed steel, and in a large number of cases new shapes of tools had to be developed to utilize successfully the full cutting capacity of these new machines. They also fulfilled the requirements of scientific management, inasmuch as they were able to determine and maintain positive production schedules along with productivity of machines.

The advent of the single-pulley machine made it possible to attach or couple an electric motor directly to the machine, thus making the machine, so arranged, a self-contained operating unit. The variable-speed motor, very popular at the beginning of this century, was quite frequently used as a speed variator, replacing some of the transmission gearing, and providing at the same time a greater number of speeds with very close increment. This of course allowed a more efficient and satisfactory selection of speeds or feeds. The variable-speed motor had the disadvantage of being inefficient at low speeds; it was of larger dimensions than the conventional constant-speed motor, and its price was considerably higher, thereby decreasing its popularity. At that time alternating current was fast replacing direct current, and thus the variable-speed motor disappeared very quickly as a driving member for machine tools. Only in a few cases, such as the drive of planers and work-head drive of grinding machines, was it maintained with usefulness and popularity. Its advantages on such applications are so great that quite frequently a motor-generator set is used to convert alternating current into direct current.

The machine tools just described had generally one element which was considered as the prime mover and from which the various transmissions led to the work and tool holders. This arrangement requires quite frequently lengthy, complicated, and expensive transmissions. With the popularizing of the electric drive, machine tools were frequently equipped with a multiple number of motors so arranged that each motor drives independently a certain transmission. The electrical connections are so arranged that the stalling of one motor will automatically stop the entire machine. Machine tools of tomorrow will probably more and more make use of this type of transmission drive.

Not being able to consistently use the variable-speed motor, but realizing certain of its important advantages, the machine-tool designers attempted to maintain these advantages by the use of hydraulic power transmissions. Uses of pump-motor units as variable-speed transmissions are old and were frequently employed in other industrial applications. To make these applications to machine tools there was first required a simple and efficient unit of relatively small proportions and at a price competitive with other conventional speed variators. It also was required that such a unit be suitable for the peculiar conditions of the particular machine tool. Thus there is found the hydraulic mechanism used on grinding machines, where very little power is required but a steady and smooth movement of the work slide is necessary. Then the hydraulic mechanism was applied to broaching machines, where the cushioning effect for the tool against shocks is an essential requirement to safeguard the expensive tool used on this type of machine. Then hydraulic transmissions were applied to drilling and milling machines, where fast, idling movement of the slides is an essential factor in the productivity of the machine, and where infinite selection of working feeds, manual or automatic, ease of control, and greater tool life are highly desirable factors. Summing up the advantages of hydraulic transmission, it might be said, first, that it gives an infinite selection of speeds or feeds; second, it protects the machine and tools from overloading and breakage; third, it provides ease of control; fourth, it gives greater tool life, due to its cushioning ability of absorbing shocks; and fifth, it makes the automatic change of feed or speed rates easily possible. Taking all of these advantages into consideration, it can readily be assumed that the hydraulic transmission will be more and more popular in machine-tool applications.

The time- and motion-study era brought a revolutionary arrangement in the control of modern machine tools. Previous to this time, levers and control elements on the machine tools were placed anywhere around the machine to maintain, as each individual designer saw it, simplicity of parts. Now the centralized control of the modern machine tool appeared. The speed- and feed-change levers had to be designed to perform their functions quickly and easily. The levers for controlling rotation of work or tool and feeding of the various elements had to be placed within easy reach of the operator when in his normal working position, and they also had to indicate the direction of rotation or feed of the elements affected. On such machine tools where a fixed stand of the operator could not readily be established and where there was a multiple number of operating positions, these levers were frequently duplicated in order that control of the machine would be possible from any position of the operator.

Besides properly locating the various controlling elements within easy reach of the operator, it was further found advisable to reduce his manual efforts to a minimum. Thus there is seen power rapid traverse replacing the manual movements of slides,

and direct and simple operating levers indicating on dials the rate of rotation or traverse or direction of movement. Even the conventional change of rate of rotation or traverse by hand on some machine tools has been replaced by power-shifting means. It might be stated that the trend in modern machine-tool control is toward conserving the efforts of the operator in order that he may produce greater accuracy and better quality of work. The hydraulic transmission and hydraulically operated mechanism simplify the efforts in these directions.

It has been shown that the development of machine tools from the standard machine, once conceived, was generally toward improved transmission mechanisms and improved control elements. These improvements created machines of higher productivity and greater accuracy in the work produced. But with the increase in the number of machine tools used, and the trend toward using these machine tools to their utmost capacity, demand came from the user of machine tools for machines of productivity and greater accessibility in case repairs or overhauling had to be done. The latter point created the so-called unit-design type of machine tool; that is, a tool in which the various mechanisms are housed in individual self-contained units, and these units, mounted on the main structure of the machine, gave the finished tool. As to durability, a number of factors common to other industrial machinery were utilized by the machine-tool designer for improving his product. He took from the automobile industry the sliding gears made of alloy steel, and integral keyshafts, and thus improved his transmission for the drive and feed mechanisms. He incorporated anti-friction bearings in his machine for the important bearings, thus increasing life and efficiency of these mechanisms. He eliminated the dozens of independent oil cups which had to be served daily by the operator, and installed automatic and centralized lubrication into his machines, thus sending the old squirt can into the discard. Slide and guide ways, subject to natural wear and exposed to chips and grit, are better protected, and in many cases made of hardened material. When the motor-driven machine became more and more the standard machine, the old way of hanging the motor to the main frame of the machine was discarded, and the motor was placed in a compartment inside of the machine, thus eliminating the possibility of exposing it to dust, dirt, and chips.

From the foregoing it is clear that machine tools were structurally conceived and functionally improved up to their present high standard. They became heavier and more powerful, and there were incorporated features for faster and easier control. The work produced by them is finished in a minimum of time to a high degree of accuracy. As an illustration of the increase in weight and power of machine tools during the last thirty years, there have been selected the various models of a No. 4 Cincinnati knee-and-column-type milling machine during this period. This milling machine was selected for the reason that accurate data were available in the files, but generally any type of machine tool during this period would indicate similar facts. The increase in power and weight also represents generally a newly designed machine, so another conclusion from these figures is the fact that machine tools in general are often redesigned and become obsolete very quickly. The following are the weight and power changes on a No. 4 plain milling machine of the same range of capacity:

Year	Weight, lb.	Power rating, hp. (approx.)
1900	4450	3
1905	5370	5
1907	6800	10
1913	7400	15
1920	8900	15
1924	9200	15

Machine tools in general can be grouped into two classes:

1 The general-purpose machine
2 The manufacturing or high-production machine.

In the development of machine tools the general-purpose machine was the first conceived. Its function was to finish parts varied in size, as well as shape, to predetermined dimensions. The quantities generally were very small, and therefore the machines had to be reset quite frequently for the different parts to be finished. Thus from the general-utility standpoint, this type of machine is of the most highly organized nature. On this type of machine there are found completely and fully developed speed- and feed-change mechanisms to take care of the great variety of work diameters or tool diameters and to provide for the individual requirements of various materials to be machined. These machines have highly organized control mechanisms, enabling the operator to quickly, safely, and conveniently control the various functions of the machine, and in these machines the structural elements are arranged in such a way that smaller or larger pieces can be machined satisfactorily with the various types of tools. These machines are in many cases developed to such a degree as to be capable of producing parts in large quantities. Thus there is seen in the general-purpose machine one which economically produces parts singly or in small quantities. However, the modern general-purpose machine is designed so rigid and powerful that in many cases it is advantageously used as a quantity-manufacturing machine. A number of attachments supplied as accessories with these machines makes it possible to perform operations normally done on another type of machine tool.

The manufacturing or high-production machine might be subdivided into (*a*) the single-purpose or special-production machine and (*b*) the standardized manufacturing machine.

The single-purpose or special-production machine is, as the name implies, a machine specially designed and constructed to perform a particular operation or series of operations. It generally is a simplified machine built of very heavy and rigid structure, but with a very limited number of speeds or feeds, and lacking the adjustments necessary to adapt it to other classes of work. These machines usually have highly developed automatic cycles of movements of work and tool, so that the duties of the operator are generally confined to starting and stopping the machine and chucking and unchucking the work. Since these machines are designed for only a single purpose, naturally they are structurally simpler than the standard machine, and therefore they are more rigid and compact. When a change is made in the design of the part that they originally are intended to produce, this type of machine either becomes completely obsolete or a complete rebuilding is necessary to make it adaptable for producing the newly designed part. It is quite natural that in the development of these single-purpose machines two or more operations at one chucking of the work are performed by employing a multiple number of cutting tools. Quite frequently these machines have such a high productivity that, even if they are running only part of the working time, they are a good investment for the user.

The manufacturing machine might be considered as a combination of both the general-purpose and the single-purpose machines. It has taken from the former its flexibility for producing various work pieces and from the latter its high-productivity qualities.

As stated, if any change took place in the parts to be machined, the single-purpose machine became obsolete. In the quantity-manufacturing machine there is provision for speed or feed changes as well as for any other adjustment. These adjustments, however, are not so easily and quickly accomplished

as on the general-purpose machine. In its cycle of operations quite a large variety of movements can be obtained, so that in the change from one part to the other it is required only that the fixture or work-holding means either be replaced or that some changes or adjustments be made to make this fixture suitable for the next part to be produced. These machines are built as single or multiple operating units. With a certain standardization of units, manufacturers of this class of machines are quite frequently able to take existing standard units and to build combination machines with as many work- or tool-holding members as may be desired by the customer. With the exception of very highly specialized production, the manufacturing machine is more and more replacing the single-purpose machine, due mainly to the fact that it is a standard machine tool, and thus can be bought cheaper and be obtained within a reasonable length of time, and also does not become obsolete when a change is made in the design of the parts to be machined.

While thus from time to time a complete change in design of machine tools has taken place and their productivity has been increased, quite frequently a change in the method of producing certain parts has added further productivity. The working of a number of tools on the same piece; the combining of different operations, such as, for example, turning and drilling; the reciprocating or indexing cycle, where the tool is working on one piece while at a different station another piece is chucked or unchucked—all these factors have brought the machine tool to the high standard of productivity of today.

In these developments the improvements in cutting tools have played a very important part indeed. The old carbon-steel tool, while frequently still in use today, has been replaced by the high-speed-steel tool, and changes in clearance and rake angles and shapes have increased the life and cutting capacity of the tools. To illustrate the advance in cutting capacity of machine and cutting tools, the following figures may be of interest. They represent the metal removal in cubic inches per horsepower-minute of a spiral milling cutter in steel of approximately 55,000 lb. tensile strength. In 1907 it was considered good practice for a milling machine to remove $^1/_8$ cu. in. of this material per hp-min. with a spiral milling cutter made of high-speed steel. In 1913, so-called wide-spaced cutters could remove $^3/_4$ cu. in. of this steel per hp-min. In 1918, these same cutters with undercut or rake angle would remove $^9/_{10}$ cu. in. of this steel per hp-min. In 1924, with the incorporation of roller bearings in the drive of a milling machine, and sliding gears in this drive replacing the old tumbler construction, $1^1/_4$ cu. in. per hp-min. was removed; and in 1928, with hydraulic feed mechanisms replacing the conventional gear feed-change mechanism and an improved simplified drive to the cutter, $1^1/_2$ cu. in. of this steel per hp-min. has been removed.

To illustrate the growth in the productivity of machine tools, there is given a comparison of methods for splitting and straddle-milling operations on connecting rods, from 1910 to 1930. These data express in terms of productivity the development which has taken place, not only in improvements on the machines, but also in the improvement of the method for producing these parts.

Date	Description	Production per hour
1910	4 pieces are held in special fixture on table	40
1915	3 pieces held at each end of hand-index base	60
1920	6 pieces held in removable work-holding unit; load extra work unit while milling	90
1926	4 pieces held in hand-index fixture	110
1928	4 pieces held in automatic-index fixture	125
1929	4 pieces held in automatic-index fixture	140
1930	8 pieces held in automatic-index fixture	248

Another good illustration showing the increase of productivity of the modern machine tools in the grinding of valve tappets is as follows:

Up to		Pieces per hour
1920	Center-type grinding[1]	90
1923	Centerless infeed grinding, hand operated, hand chucking, hand removing[2]	150
1924	Centerless infeed grinding, hand operated, hand chucking, lever ejection[2]	240
1925	Centerless infeed grinding, hand operated, hand chucking, automatic ejection[2]	300
1927	Centerless infeed grinding, automatic infeed, automatic ejection[2]	450
1929	Centerless infeed grinding, hopper feed, automatic infeed, and ejection[2] (three machines operated by one man)	1350

[1] Tolerance plus or minus 0.0005 round and straight.
[2] Tolerance plus or minus 0.00025 round and straight.

This last operation shows another trend in machine tools. Here is one operator taking care of a multiple number of machines, which automatically perform day after day a certain operation, and the function of the operator is confined to supplying the hopper with parts, to supervising the proper functioning of machines and tools, and to checking the work as to predetermined size and finish.

As to further developments it is reasonable to assume that the machine tool of the future will be structurally heavier, more rigid, and more powerful in its cutting capacity. With the trend toward higher cutting speeds of tools and the desire for machines to operate more smoothly and quietly, will come a development either to improve the existing gear transmissions or to substitute for them some other means. This development might be toward frictional, hydraulic, or electrical mechanisms. The control of the machine will be further refined in the direction of ease and simplification of operation.

The cycle of production for any part may be divided into three subdivisions: the chucking, the machining, and the unchucking of the work. On a machine where these divisions are independent of each other—that is, where a single piece is being worked on and must be removed before a second piece can be chucked—the time of each of these divisional operations affects the total production time of the piece. Any reduction in time of any of these divisions will naturally improve production. On the other hand, where the chucking and unchucking of the work are done while the tool is working on another piece (chucked previously) and where chucking and machining time are properly balanced, improvement in any one of these divisional operations will not affect production. To obtain an improvement in this latter case both chucking and unchucking, as well as the cutting operation, must be jointly improved. With the advent of cemented tungsten carbide tools, high cutting speeds have in some cases materially reduced machining time. To obtain beneficial results in the latter case, therefore, it is necessary that the chucking time should be improved proportionally. That will probably mean a further departure from the manual clamping of work and an increase in the use of automatic clamping devices.

In the years gone by, methods of shaping parts have been replaced by new ones. The file was replaced by the planer; the grinding machine replaced the lathe for the finishing operation; milling machines took work from the planer and shaper, and so on. The welded steel frame has in some industries already replaced the cast structure. It is safe to assume that these developments will gain in popularity and will replace certain machining operations by welding. These changes will not stop, and the future will find some of the present-day standard operations performed by new methods and on new types of machines.

When James Watt required an accurately bored cylinder, a machine tool was produced to meet his requirement; and so on through the history of the industrial development, machine tools have taken a leading part in helping to produce all the necessities and comforts that characterize our present-day standard of living.

Decentralized Employee Training

Evolution of Employee Training From the Time of the Apprentice and Master Craftsman to the Present—Now Confined Largely to Training for the Job, on the Job, by Supervisors Who Have Been Trained to Train

By W. J. DONALD,[1] NEW YORK, N. Y.

THE training of employees in business is as old as the relationship of master and servant, but methods have been changing with the changes in industrial and commercial organization, and of recent years have been affected substantially by modern principles of educational psychology.

The training of manual workers has thus far received much more attention than that of those often referred to as "white-collar workers," such as retail sales people, office workers, and persons who sell to retail stores, to the consuming public in their homes and offices, or to institutions or other manufacturing companies.

Comparatively speaking by far the greater percentage of those gainfully employed in America have heretofore been engaged in manual occupations, but the distribution of workers is rapidly changing because the increase in the size of business is increasing the number of office operations more than in an arithmetical ratio, and the keenness of competition has brought about a rapid increase in the number of sales people.

As a result, the American census of 1930 will undoubtedly show a very considerable increase in the percentage of gainfully employed who are engaged in "white-collar" occupations, and consequently the attention which heretofore was devoted solely to the training of manual workers is now gradually being shared equally or even to a greater extent with the training of commercial employees.

It is only natural that the training of manual workers has acquired a certain stability which is attended by distinct disadvantages, particularly a comparatively marked lack of progress.

Training of Commercial Employees Comparatively New

The training of commercial employees, that is, office workers and sales people, is comparatively new, and while it suffers somewhat from the traditions that have been borrowed from the field of training manual workers, nevertheless in many quarters the training of commercial employees is being attacked from a new angle by men scientifically trained in educational psychology and methods, and there is distinct evidence that the recent progress in such training is having a definite effect on the training of manual workers—so much so that educational directors in charge of training manual workers are re-evaluating their objectives and methods and adapting to their situations the methods which are being applied in the training of sales people and office workers.

As a management policy, the training of workers is becoming more and more important. In the first place, the stoppage of immigration by the Great War and its restriction since have limited not only the supply of manual workers but also that of office employees and sales people. No longer can an ample supply of unskilled workers be secured from the steady influx of immigrants. Wages have rapidly increased. A rapidly increasing percentage of foreign born speak English, this percentage being influenced by the fact that the annual influx of non-English-speaking persons is relatively much less important in relation to the total of English-speaking than before the war.

High wages for manual work in factories made manual work for females more attractive, and women workers who might otherwise have entered commercial occupations were attracted to factory work, leaving a dearth of them for offices and sales positions as compared with what might have been the case had the earnings of manual workers not increased.

Another new factor in the realm of office and sales positions in particular has been the trend toward the measurement of office and sales output, with a consequent increase in output per day per worker, out of which can be paid a higher scale of earnings. As yet, however, comparatively few office workers are paid on a piece-work basis or its equivalent. A somewhat larger percentage of sales people, either in department stores or elsewhere, are paid on a commission or partially on a contingent basis.

If a high wage policy is accepted, either as a matter of sound business or of necessity, it becomes imperative that under a daily-wage or straight-salary plan attention must be given to training if the unit cost of output and of doing business is to be kept down a point which is essential in an era of keen competition. Consequently employees, whether they work on a salary or on a contingent basis of compensation, must be trained by their supervisors in order that their output may be commensurate with the compensation they receive.

The payment of employees, especially retail sales people or other sales employees, on piece rate or on a commission or other basis of compensation contingent on results is usually attended by a comparatively high turnover, and it is well recognized that excessive turnover of employees is expensive, not only because of the cost of employing, but also because of the high cost of initial training and introduction to the job, and especially the training that is necessary during the first few months of work when a new employee is probably not fully earning his or her compensation, at least in proportion to others.

This turnover among commercial employees is more costly than formerly because of the comparatively high earnings of the present decade, and it is especially high in those occupations where earnings are contingent upon output, because an employee who cannot quickly learn to earn close to the average is very likely to become discouraged and resign.

[1] Managing Director, American Management Association. Mr. Donald received the A.B. degree from McMaster University, Canada, in 1910, and that of Ph.D. in Economics from the University of Chicago in 1914, after three years as fellow in that institution. He then served as head of the department of economics of McMaster University until 1917, when he became connected with the American City Bureau, in charge of civic campaigns, city planning, zoning studies, etc. In 1921 he became managing director of the National Association of Corporation Schools, now, after several mergers, known as the American Management Association. He has contributed numerous articles and papers on management subjects to the technical press and professional societies of both Canada and the United States.

EFFECTIVE TRAINING AN IMPORTANT FACTOR IN REDUCTION OF TURNOVER OF EMPLOYEES

While there are other factors in the reduction of turnover of employees such as proper selection, good working conditions, etc., nevertheless it is recognized that one of the most important of them is adequate, well-directed, and effective training.

Another phase of the situation is that a number of modern educationalists have either entered the business world as business executives or have had such close contact with the business world that it has been possible to develop methods of training more in line with modern pedagogical practice and more fitted to the training of employees in scattered groups, including workers in comparatively small offices, salesmen in the field, sales people in small stores, or manual workers in small factory units. This modern viewpoint can be summed up briefly as training on the job by the supervisor, combined with a program of training supervisors in the process of training their workers.

Historically, training dates back to the earliest appearance of the master craftsman, the journeyman, and the apprentice, the apprentice usually living in the home of the master craftsman, learning the trade from him.

With the introduction of the factory system, the personal relationship between the master craftsman and beginner changed greatly. Whereas the master craftsman had formerly been owner, manager, workman, and, to some extent, tradesman, these several functions were gradually separated, and comparatively large-scale operations introduced several levels and types of responsibility and activity which gradually widened the gap between the owner and the beginning worker.

During the period of small organizations the training function became the job of the supervisor, usually referred to as a foreman or department head. To set up any formal training program would have been too expensive, and in other ways it would have been impracticable. The training of the new employee necessarily became the function of the immediate supervisor, who regarded it as a natural part of his duties. The average foreman or department head corresponded to a considerable extent to the master craftsman of the previous age.

Meanwhile, however, a differentiation unconsciously grew up between education and training. Whereas in the earlier handicraft stages education in the sense of training for general life relationships was largely a function of the master craftsman, gradually this part of education and training was absorbed by public educational authorities, especially in America, and the master craftsman was to a still greater extent than formerly relieved of that responsibility. Thus the supervisor's function was finally confined to a much greater degree to that of training for the job on the job.

ADVENT OF CORPORATION SCHOOLS

With the coming of large-scale operations, training for the job became a much greater necessity, and industry and commerce began to give it substantially more intensive and formal attention. As early as the 1890's in America a few corporations had formed what were commonly called "corporation schools," the assumption being that the training function, formerly exercised by the supervisor, department head, or foreman, should be exercised by a department especially equipped and trained to perform the job of training the employees.

This change was due to the assumption that the department head or foreman could not be expected to train those employees who were responsible to him, partly because he was too poorly equipped to teach, partly because it was assumed that he could not be trained to teach, and partly because it was assumed that he had too many other responsibilities, particularly those which grow out of a comparatively greater necessity for reports and for other "paper" work in a system of large-scale business.

Consequently, it was not infrequent for corporations to establish schools or educational departments, appointing as the head of that department some one who presumably was better able to train employees than the supervisor. Not infrequently a public-school teacher or official was chosen for such a position, particularly on the basis of a more complete education, and often particularly on the basis of personality. Quite often these directors knew very little about educational psychology. As a matter of fact, that science was still in comparatively primitive stages at the beginning of the corporation-school movement.

By 1913 there were in America a sufficient number of corporation schools to warrant the formation of a National Association of Corporation Schools, and this organization grew substantially in influence and numbers from 1913 to 1921. Meanwhile similar associations were formed in England, in France, in Japan, and in certain other countries.

Some of these schools adopted the pedagogical methods which had been in vogue in the public schools and in colleges during the time when the director of education had attended them. Without any particular knowledge of educational methods, he naturally adopted those with which he was most familiar, including often the formalism of the classroom and its more or less inevitable removal from occupational activity and other economic relationships.

This movement embraced a goodly proportion of companies which were interested in the training of commercial employees, that is, stenographers, typists, and dictating-machine operators, bookkeepers, clerks, retail-store sales people, and salesmen who traveled to sell to department stores or other retail companies, as well as companies interested in training manual workers, especially apprentices. There was even considerable attention given to training for export work.

Banks, insurance companies, publishing houses, department stores, security houses, and even manufacturing companies, paid attention to the training of commercial employees. They were influenced very largely by the practice of manufacturing companies in the training of apprentices and other manual workers, not recognizing that manual workers in factories are usually concentrated in large numbers in one location, whereas office employees are usually comparatively small in number, and sales people often work individually out of branch offices under comparatively intermittent supervision.

The war and the dearth of workers for offices and sales jobs emphasized the need for training, and employers grasped at every straw to solve their problems.

Unaccustomed to thinking about training problems as a part of their own jobs, the average executives naturally wished to delegate the new activity to others, believing that in this way they had absolved themselves from all responsibility for training. Often, in addition, this motive was supported by a certain moral satisfaction over providing for the training of employees.

Business executives have no monopoly on visual-mindedness. But, if they can see desks, classrooms, blackboards, and a classroom full of students, to most of them it seems perfectly apparent that an effective job of training is being done. If to this physical evidence of training can be added graduating classes, certificates of graduation, records of attendance at classes and similar devices, they are easily persuaded that a remarkable training job is being done.

Whether output is being increased by such methods as effectively as it might be by other methods, is a little difficult to grasp.

To sum up, it was only natural that in the first stages of training for employees, emphasis should be laid on those conspicuous evidences of training which superficially would seem to indicate their value.

By 1919 it had become apparent in America that many corporations were training employees without the formality of a corporation school, and this trend of thought found its expression in the renaming of the association "National Association of Corporation *Training*." These informal training programs appeared more particularly in offices and among sales forces—in other words, among commercial employees.

A few companies, particularly one large publishing house, had already developed an extensive program of training which made no use whatever of the corporation-school idea with its classes, formal instructors, examinations, etc., and this corporation had made a notable success of its training program.

Meanwhile there had come into business or into close relation with it a group of men who were leaders in the field of educational psychology and method, most of them thinking in terms of the project method of teaching.

TREND TOWARD THE PROJECT METHOD OF TEACHING

For teaching purposes a project may be defined as a problematic act carried to completion in a natural setting. Applied to business, this means that training should be carried on under natural conditions of responsibility, supervision, and incentive, and under normal working conditions.

In recent years there has been a strong tendency for corporations to abandon the formal classroom-instruction method of training and to return to the earlier method of making training fundamentally the responsibility of the department head or supervisor.

There is, however, this very important difference that is being recognized, namely, that the supervisor should be trained in the teaching process, and that he can be trained to teach. We have abandoned the attitude that a teacher is born and not made, and we are rapidly abandoning the attitude that a supervisor, such as a foreman or office-department head, cannot be taught better methods of training.

Furthermore, we now recognize that the instructional material for training purposes, usually referred to as "instructional outlines," must be organized in such a way that the supervisor will cover all aspects of the training program so that they will not be left to mere chance or individual whim.

During this change in methods of training employees, public educational authorities were giving more and more attention to the preparation of youth for industrial and commercial pursuits. The industrial and trade school supported as part of the public educational system became quite general.

The first tendency in this movement was to assume that the public schools could take a very large part of the program for training for business as well as education for life relationships, and for a time it was easy to find vigorous advocates of public educational institutions which would entirely relieve business of the problem of training for the job.

BUSINESS CANNOT TRANSFER TRAINING PROBLEM ENTIRELY TO PUBLIC SCHOOLS

In recent years there has been a distinct swing away from the assumption that the public schools could entirely relieve business of its own responsibility. It is now realized that the public schools have failed to perform the whole task of education and training for occupational activity, that the failure was inevitable, that the problem cannot be transferred in its entirety to the public schools, and that business, whether it wishes to or not, must assume its own share of the responsibility for training.

An increasing number of public educational leaders have accepted this principle, at first with regret, and more recently with some degree of enthusiasm.

At first, many corporation schools undertook what is generally conceded to be the responsibility of the public schools, namely, that of educating young people and even others for the broader relationships of life, most of which, of course, have some bearing on the effectiveness of an employee in his occupation. In a few cases this tendency was inspired by a successful chief executive of a company who had had few educational advantages himself and who wished his employees to have greater advantages than he had enjoyed. Paradoxically, his lack of these advantages had not conspicuously affected his own business success. For the most part this tendency has been and is being abandoned.

Organized business now expects the public schools to prepare youth for most life relationships, and by eliminating this feature from its own program, business can devote itself more intensively and effectively to training for the job.

In many quarters the terms "education" and "training" are used interchangeably; in others a distinction is made. For instance, by some education is interpreted as referring to the general training for life relationships, and training as a preparation for an occupational pursuit.

Dr. James H. Greene in his book, "Organized Training for Business," page 1, states that the term "training" should be restricted in its use to the organized learning-process situations where the acquisition of skill in technical processes or success in meeting definite commercial or industrial problems is the goal. To him training is a part of education, and for purposes of further discussion his definition may be accepted as fundamentally sound.

Time was when it was believed that training should be directed to the benefit of those who were comparatively new in business or in a particular activity. The emphasis on training for younger workers was particularly due to the conviction that older employees gradually lose, and ultimately lose altogether, the capacity for learning. Such a point of view also took it for granted that older workers could not be trained for new jobs or for transfer to other activities, or, for that matter, even for promotion. Another assumption was also implied, namely, that older workers, especially executives, had already learned all there was to learn. Another background of these points of view was an assumption that the learning process had to do with the acquisition of knowledge of facts, and it was not clearly evident that the learning process is not complete until the learner's skill has been improved or, psychologically speaking, until there has been a change in his habits of action.

MANAGEMENT LARGELY A TRAINING JOB

Today there is a very different point of view. The president of one of our most progressive companies has frequently said that management is in large measure, eighty to ninety per cent, a training job. He illustrates by saying that on one occasion a number of executives of his company analyzed exactly what management is in terms of specific operations, and that after classifying all of the typical operations, nine out of ten of them were listed under education and training.

Along with other executives, of whom there are many, he regards the training of his immediate associates as a major part of his executive responsibilities, and assumes that the training responsibility goes on down through the organization from one supervisor to the next, and finally to the last or lowest rank of employees.

These major executives even assume that their own training is not yet complete, that business experience itself is a continual process of training, and that, furthermore, they may profitably share experiences with others in conferences and conventions, by reading, and by consultation, for the purpose of developing their own capacities in the rapidly changing business world.

It is well recognized, for instance, that the spread of large-

scale business has brought with it problems of coordination and decentralization of executive responsibilities with which very few business executives are fully prepared to cope, because the methods of operating large-scale organizations require not only the necessary machinery and organization set-up, but also the grasp of a spirit and technique of development of executives without which the mere machinery of large-scale operation will be cumbersome and subject to a vast amount of friction.

If this sweeping pervasiveness of the need for training is accepted, the question, "Who should do the training?" becomes comparatively simple. There is only one possible answer, namely, that every supervisor must train. This conclusion must be perfectly evident simply as a matter of practical expediency. Office employees of a large corporation are frequently spread in small groups through many offices, either in the same building or even in separate buildings and even separate cities. Salesmen travel from city to city or from section to section of one city. Retail sales people for the most part must spend their time in their departments, meeting and serving their customers.

Furthermore, the great majority of employees who have suffered under the formalism of school and college have a conviction that school days are or should be over. Training for adults must as a rule, if it is to be favorably received, avoid those features which remind one of his status during youth. This principle is valid even to the extent that some companies have avoided the use of the term "training" and have substituted some term such as "development," and many of them have used conferences as a means of developing employees, meetings in which there is as little as possible of the flavor of a formal classroom.

Training of Employees by Supervisors Sound Pedagogically

Pedagogically, too, the training of the employee by the supervisor is being accepted as essentially sound. The great weakness of much public-school education, especially in the past, is that the student experiences no activity by reason of which his habits of action may be changed or new ones formed. In much school work the learning process is still a passive one. We are all well aware, however, of recent developments in the educational world which have linked the learning process with activity, and, in the industrial and trade educational world, to some extent with occupational activity, at least in miniature.

In business the restrictions and handicaps with which the public educational leader is faced practically disappear. Public-school leaders in educational thought would give their eyeteeth for the educational opportunities which lie at the hand of every business executive and every supervisor.

In business the student-employee, whether old or young, a new employee or a veteran, may be trained or developed on the job under normal conditions of supervision, responsibility, and other working conditions through his own activity and under conditions in which his habit of work and thought may be changed and new habits and skills acquired by practice, and under conditions by which the results of the training may be tested through some measurement of output or other results.

This point of view has been adopted in certain outstanding companies and lines of business. In contrast to the training of life-insurance salesmen at a head-office school, a practice which was prevalent a decade ago, the most progressive life-insurance companies are training their salesmen by having them actually practice selling, meeting the selling difficulties under normal conditions, and then learning from older and more experienced salesmen or from a supervisor the best methods of dealing with them. The salesman finally acquires new habits and skills which he applies with success, and to his own financial benefit as well as to that of his company. Such training must naturally be given by the supervisor in a branch office or agency.

Successful Results of Decentralized Training

In practice this policy has greatly reduced turnover or failure of salesmen, has increased the output and earnings of salesmen and the profits of the companies, and has usually resulted in a rapid expansion of the total volume of business done by the company.

In other lines of business the same practice applies in the training of office employees—stenographers, clerks, bookkeepers, etc. Banks, for instance, have pretty generally abandoned the formal classroom method of instruction and are training their new and older workers on the job under a supervisor capable of training the new employee or one who is marked for promotion.

In several electrical, telephone, and manufacturing companies, the same practice of decentralized training has been adopted, especially by large companies which formerly were wedded to centralized training by an educational department.

This trend in the training of employees in America will not be successful if not accompanied by a complementary program of training supervisors to train, which, after all, is rapidly becoming the most important part of a training program in American business.

Not all supervisors, in fact very few, are born trainers, but it is equally true that very few supervisors are incapable of becoming good trainers. In any case, it is quite true that there is no supervisor who ought to be one whose technique of training his immediate associates cannot be improved. Even those supervisors who are best equipped naturally to train employees can acquire better habits and skills in actually training them.

The central point in training employees within companies is the training of supervisors to train. One of the largest electrical companies in America has practically done away with all formal classroom instruction of employees and is concentrating its efforts on training the supervisor to train. The syllabus of the supervisors' training program consists largely, practically ninety to ninety-five per cent, of material which deals with teacher training, the assumption being that in order to make the training program really effective, steps must be taken to make the training of the employee continuous from the time of entering the business until he leaves it, and on the principle that the best training is that which is given in connection with actual work under normal circumstances of supervision, incentive, and responsibility.

Preparation of Instructional Material a Most Important Step in Training Program

The preparation of instructional material is, of course, one of the most important steps in a training program. At one time the usual practice was for the instructor himself to learn every element of the job and then proceed to convey the information to the employee, usually by the lecture process in classroom. More recently, emphasis is being laid on the job difficulties of the employee, and the result has been a pronounced movement in the direction of analyzing the job and the learning difficulties of the employee, and setting up the order in which the latter appear. Out of this analysis it is possible to formulate a body of instructional material which attacks, not training for the whole job, but rather training the employee to overcome the job difficulties, and to set up a learning order which will, so far as possible, solve the worker's job difficulties in natural sequence and, so far as possible, as they appear in his daily activity.

In the preparation of instructional material it is generally conceded that the supervisor who should do the training ought to have a share in preparing its outlines. In fact, he ought to have a share in preparing the whole training program. This is more or less a matter of tactics in order to enlist the wholehearted cooperation of the supervisor by making him feel and be-

lieve that it is not simply a program superimposed on him. Furthermore, his participation in the preparation of the training program and the instructional material is a very effective part of his preparation for the training process.

In the training of supervisors to train, the same principle applies as in training the rank and file of employees. Here again practice makes perfect, but supervised practice is much more likely to bring perfection than unsupervised. The alternative is that supervisors who undertake to train are as likely to become habituated to useless or ineffective practices as they are to acquire the more skilful ones.

This point of view simply parallels the generally accepted principle of training public-school teachers to teach by giving them supervised practice in schools of education or in normal schools for teachers. Its effectiveness where the plan has been used in business is well vouched for, and it is rapidly superseding all others.

An important step in a modern training program for employees which accepts the principle of decentralized training by the supervisor is an analysis of the teaching process in terms of difficulties of the supervisor or department head in training his employees on the job, for the job. Such an analysis leads to the development of a body of instructional material on the technique of training.

Actually, it has been found by some companies that it is well to present a number of successful methods of meeting such job difficulties, recognizing that different persons may need to use somewhat different methods, especially with different types of employees. This practice has the additional advantage of removing what is frequently a supervisor's alibi, namely, that he has tried a recommended practice and that it has not been successful. To such a supervisor the obvious answer is that "other methods have been suggested—try them. All of these methods have been successfully used by some supervisor. Find the one which for you will be successful, or invent a new one which for you will be effective."

There is implied in this answer the alternative that the supervisor in question may not be entitled to hold the position of supervisor.

Functions of Educational Director Under a Program of Decentralized Training by Supervisors

What has happened to the educational departments or educational directors of former days? A very large number of companies still have what is commonly referred to as an educational or training department, or an educational director or manager of training activities.

There are no definite signs that the number of such departments have decreased or that they ever will decrease. The men who held such positions have in some instances been transferred to other work in or out of their companies. Other directors of training activities of former days have themselves grown and changed their points of view and aligned themselves with modern training trends.

It may well be asked, "What is the function of such an educational director or manager of training activities under a program of decentralized training by the supervisor on the job for the job?"

The best practice of today recognizes the following functions of such a department:

1 To provide that enthusiasm and promotive quality which spreads interest in training throughout the organization and creates desire and willingness on the part of every supervisor to take part in the training process.

2 To help to prepare the instructional outlines to be used by supervisors in the training of their workers. One says "help" advisedly, because it may be easily recognized that when the supervisors themselves have prepared the instructional outlines with the help of an educational department, they are much more likely to take an interest in the training program and to feel a definite responsibility for making it effective.

3 To prepare, improve, and constantly revise the procedure for carrying out the training program, thus facilitating the work of the supervisor.

4 To take a very active part in training the supervisor to train

5 To act as an adviser to the management of the company in regard to the development of its personnel, and thus link the training policy of the company to the whole future of the business and its financial success.

Time was when educational and training departments were usually set apart from other personnel activities. A training department was paralleled by an employment department, an industrial relations department, a welfare department, a health department, etc. This stage of thinking about training and personnel administration in general was a period during which there was a National Association of Corporation Schools and also a National Association of Employment Managers. It assumed that one department employed people without any responsibility for training, and that another department trained employees without any responsibility for selection and without responsibility for output.

In 1922 these two associations were merged as the National Personnel Association, because it became evident that personnel administration is essentially a unit; that employment, training, placement, transfer, and promotion, and even compensation, are all different phases of the same problem. The effort to train employees who are not adapted to the work is fruitless and a waste of energy and funds.

But progress was not yet over. By 1923 it had become evident that personnel administration is an integral part of management, that every supervisor and every executive must devote himself to a very great extent to personnel problems. As Oscar Grothe, vice-president of the White Sewing Machine Corporation, who is very active in the training programs of his company, says, there is in reality no personnel problem—there is only a management problem.

The consequence was that in 1923 there was a further change of name to the American Management Association, which organization devotes more attention than ever before to problems of personnel, including the training of employees. It is now quite clearly recognized that training is a management problem, not simply a management problem which may be delegated to a training department but rather one which is the responsibility of every executive from president down to the last supervisor, and which executives may solve most effectively with the help of a personnel department in which there will probably be found, on the average, a director of training activities.

From a stage when education of the worker was in large part a function of the master craftsman and training of the workman entirely so—the master craftsman, however, being ill prepared to teach except in terms of the mastership of his craft—we have progressed through a stage of formal classroom instruction of employees, partly for educational and partly for training purposes—a period of mass production in training—to one where the educational and training work of companies is being confined largely to training for the job, on the job, by a supervisor who has been trained to train.

Employee training has thus come to be recognized as a management problem, and the stage has arrived where the subject of training employees takes a very large place in all discussion of management activities.

Fluid Metering in Practice

Offered as a Basis for the Revision of Part 1 of the A.S.M.E. Fluid Meter Report

By ED S. SMITH, JR.,[1] PROVIDENCE, R. I.

The paper on "Quantity-Rate Fluid Meters" presented by Ed S. Smith, Jr., at the World Engineering Congress held in Tokio last year, was prepared as a summary of his experience in conjunction with the other earlier work on the subject and especially the papers "Discharge Coefficients of Square-Edged Orifices for Measuring the Flow of Air" by Messrs. Bean, Buckingham, and Murphy, and "The Laws of Similarity for Orifice and Nozzle Flows" by John L. Hodgson, which in particular have the latest discussions of dimensional analysis as applied to fluid measurement.

As this paper was intended by Mr. Smith to be used ultimately as a basis for proposed revision of Part 1 of the Fluid Meters Committee Report, it is thought wise to again present a portion of his paper for definite criticisms by those of the Society who are interested in fluid flow. Comparison of this material will show the difference in basis of development from the present Fluid Meters Committee Report. The material offered for present consideration is Chapter 1 of Mr. Smith's paper. Comments, suggestions, or criticisms are earnestly invited from engineers interested in the problems of fluid flow.

R. J. S. Pigott.[2]

The Hydraulic Equation

IT IS CONVENIENT to use the "hydraulic" formula, which assumes that the fluid is neither appreciably viscous nor expansible, with experimentally determined coefficients for the effects of viscosity and expansibility.

This hydraulic formula is

$$Q_w = CY \frac{A_1}{\sqrt{(D_1/D_2)^4 - 1}} \sqrt{2PW_1} \quad \ldots\ldots [1]$$

or

$$Q_w = CYA \sqrt{2PW_1} \quad \ldots\ldots [2]$$

in which the following notation is used:

Symbol	Dimension	Unit	Quantity
Q_w	M/T	Lb. per sec.	Mass discharge
C	....	.....	Coefficient, correcting for viscosity, as determined by data correlated with the Reynolds number
Y	....	.....	Factor correcting for expansion of gaseous fluids (Y = 1.000 for liquids)
A_1	L^2	Sq. ft.	Area of inlet (pipe)
A	L^2	Sq. ft.	Effective area of section of maximum constriction
D_1	L	Ft.	Inlet diameter (or pipe)
D_2	L	Ft.	Diameter of throat of venturi tube or diameter of orifice
P	M/LT^2	Poundals per sq. ft.	Differential pressure
W_1	M/L^3	Lb. per cu. ft.	Density of fluid at inlet

[1] Hydraulic Engineer, Builders Iron Foundry, Jun. A.S.M.E.

[2] Consulting Engineer, Stevens & Wood, Inc., New York, N. Y., and chairman of A.S.M.E. Special Research Committee on Fluid Meters.

For convenient use, in ordinary English units,

$$Q_w = 457.2\, CYa \sqrt{hW_1} \quad \ldots\ldots [3]$$

in which the following notation is employed:

Symbol	Dimension	Unit	Quantity
Q_w	M/T	Lb. per hr.	Mass discharge
457.2	$M^{1/2}/T$	.....	A physical constant
C	....	.....	Coefficient correction for viscous effects, as determined by Reynolds' number
Y	....	.....	Factor correcting for expansion of gaseous fluids
a	L^2	Sq. in.	Area of venturi tube throat or orifice *vena contracta*, corrected for approach velocity
a_1	L^2	Sq. in.	Area of inlet (pipe)
a_2	L^2	Sq. in.	Area of venturi tube throat or orifice
h	L	In.	Water differential
W_1	M/L^3	Lb. per cu. ft.	Density of fluid at inlet

$$a = \frac{a_1}{\sqrt{(d_1/d_2)^4 - 1}} = a_2 \sqrt{\frac{(d_1/d_2)^4}{(d_1/d_2)^4 - 1}} \quad \ldots\ldots [4]$$

The absolute system of mass units is quite satisfactory, since using "pounds" for the mass unit and "poundals" for the force unit (grams and dynes correspondingly in the absolute C.G.S. system) gives the discharge in familiar mass units, while the unfamiliar force unit (poundal) is replaced in practical use by the differential head h.

The Coefficient

Fig. 1 shows the relation between the coefficient C and the Reynolds number for various differential producers. It is apparent that for a velocity range of 1 to 10, which is customary in commercial metering, the coefficient is generally substantially "flat" for commercial sizes of meters, the exceptions being for unusually small pipe sizes or for fluids having high kinematic viscosity, such as heavy oils or hydrogen gas.

The Expansion Factor

Fig. 2 shows the expansion factors for use with gaseous fluids for various differential producers.[3]

The orifice expansion correction is considerably less than that for nozzles. In both cases the factor depends upon the "acoustic-velocity ratio," which may be more simply expressed as the "acoustic ratio" x/n, where x is the ratio of the differential to the inlet pressure, and n is the ratio of specific heats for constant pressure and constant volume.

Although with the venturi tube these factors are computed for frictionless adiabatic expansion, it will be found that the above equation applies nearly exactly when using the friction coefficient C and the expansion factor Y here, as above stated, for metering various gaseous fluids with the usual commercial sizes of meters.

[3] The computations throughout these notes have been made with a 20-in. slide rule, and this is adequate, since the data are only presented to illustrate the method.

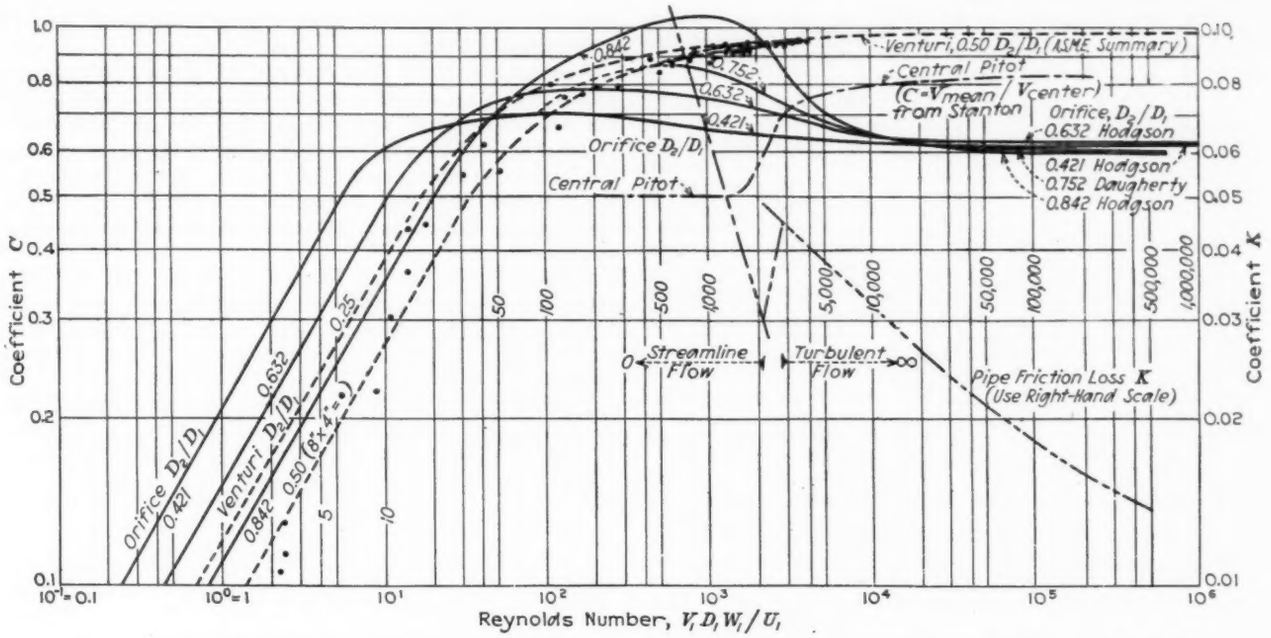


FIG. 1 FLUID-METER COEFFICIENT C AND PIPE-FRICTION LOSS K PLOTTED AGAINST REYNOLDS' NUMBER $V_1D_1W_1/U_1$

For the orifice, the expansion factor Y, as experimentally determined, includes the effect of both the increase in the size of *vena contracta* and also the expansion of the fluid itself. This expansion correction Y for orifices is best determined from high-pressure tests (R-4) in which the coefficient C is flat, i.e., has no appreciable variation with the Reynolds number.

The relation between this flat coefficient C for square-edged

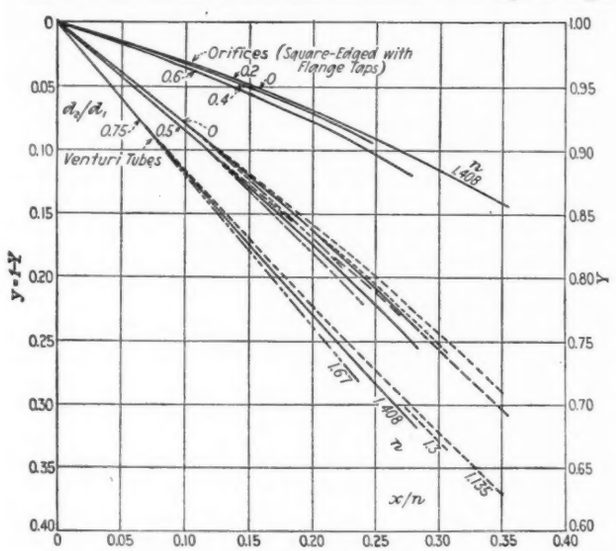


FIG. 2 RELATION BETWEEN EXPANSION FACTOR Y AND ACOUSTIC RATIO x/n

orifices having flange taps and various ratios of orifice diameter to pipe diameter is shown in Fig. 3.

The expansion correction in Fig. 2 is plotted against the acoustic ratio, which basis is entirely satisfactory for commercial metering with the differentials generally used. This graph shows that a nearly straight-line relation exists for all values of the expansion correction y and the acoustic ratio x/n. The expansion factor Y depends on the correction y as follows:

$$Y = 1 - y \quad [5]$$

It is generally most convenient to apply this nearly straight-line relation by using one of the following equations:

$$y = bx/n \quad [6]$$

$$Y = 1 - bx/n \quad [7]$$

since b is practically constant. (R-5, R-6.)

Fig. 4 shows the relation between b and the ratio of diameters d_2/d_1 for the venturi tube or nozzle, and also for square-edged orifices with flange taps.

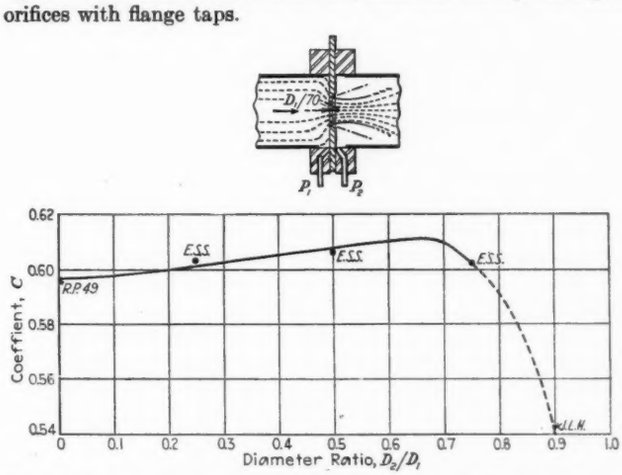


FIG. 3 RELATION BETWEEN "FLAT" COEFFICIENT C FOR SQUARE-EDGED ORIFICES WITH FLANGE TAPS AND DIAMETER RATIO D_2/D_1 AT HIGH VALUES OF REYNOLDS' NUMBER

Another familiar form involves taking the square root of a similar factor:

$$Y = \sqrt{1 - b'x/n} \quad [8]$$

However, the simpler form (which does not include the radical), $Y = 1 - bx/n$, as used above, is satisfactory for general commercial use, since the error produced by this approximation is generally less than 0.2 per cent; and also it will be observed that some adiabatic corrections for venturi tubes are concave upward and some the reverse.

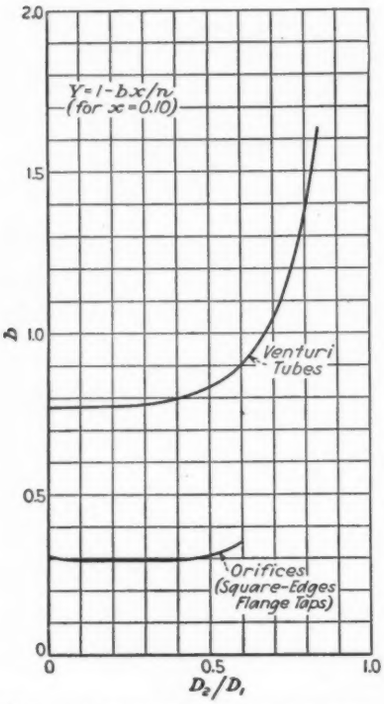


FIG. 4 RELATION BETWEEN EXPANSION CONSTANT b AND DIAMETER RATIO D_2/D_1 FOR VENTURI TUBES AND SQUARE-EDGED ORIFICES

In 1914, G. B. Upton used the following formula for venturi tubes: $b = (3 + R^4)/4(1 - R^4)$, where $R = d_2/d_1$.

For most orifices the use of the separate factors C and Y determined above will be entirely satisfactory. However, for very small orifices or highly viscous gaseous fluids it may be necessary to use the experimentally determined combined factor CY plotted against the Reynolds number for various acoustic ratios.

Although the use of the simple acoustic ratio x/n is only shown for nearly adiabatic expansions, this method will be found useful where the flow through the differential producer follows a somewhat different expansion law (as with orifices with pipe connections which really measure the "loss" due to the throttling orifice). This is due to the fact that the acoustic ratio x/n is primarily based upon the use of the velocity of the fluid in the pipe at the inlet and the acoustic velocity also at the same point, and at the usual low differentials the velocity of sound will not change appreciably along the differential producer.

The above method of metering uses only known quantities in the hydraulic formula, and the experimentally determined factors, coefficient C and expansion factor Y, are obtained from two dimensionless ratios (Reynolds' number and acoustic ratio), both of which depend only upon known quantities. Since both the Reynolds number and acoustic ratio are based upon the conditions in the pipe at the inlet of the differential producer, the above method is suitable for use with any geometrically similar differential producers.

STANDARD DIFFERENTIAL PRODUCERS—DEFINITIONS

Venturi Tube. The term "venturi tube" refers specifically to a constant-angle conical contracting inlet section having a cylindrical inlet and throat with gently curving transition surfaces, and having an annulus at both inlet and throat. A downstream pressure-recovery constant-angle cone is generally added to reduce the loss of head to a minimum, the overall length depending also upon the throat diameter.

Venturi Nozzle. The venturi nozzle consists specifically of a conoidal contracting section containing an inlet and throat connections each having an annulus (as with standard venturi-tube construction, hence "venturi" nozzle). Although there is generally no downstream recovery cone, a short cone is sometimes added which cuts the loss practically in half. This venturi nozzle is generally somewhat shorter between inlet and throat connections than the standard venturi, 1 pipe diameter being the standard distance between connections; the overall length is the same for a given pipe size regardless of the size of the throat.

Venturi Nozzle-Tube. This is merely the venturi nozzle with an added short recovery cone (of standard length regardless of diameter ratio).

Flow Nozzle. The flow nozzle consists merely of a nozzle-shaped construction which is placed between two pipe flanges. There is no annulus at either section, both connections being generally made in the wall of the pipe near the nozzle, as with square-edged orifices.

Square-Edged Orifice With Flange Connections. This consists generally of a concentric circular aperture in a thin-plate diaphragm, having single upstream and downstream pressure connections in the flanges immediately adjacent to the orifice, or in the face of the orifice itself. The leading edge of the orifice is square-edged, while the downstream edge may be beveled to make the thickness at the edge less than one-seventieth of the pipe diameter.

Square-Edged Orifice With Throat Connections. With an orifice between flanges as before, single connections are made to the pipe wall at 1 pipe diameter upstream and $\frac{1}{2}$ pipe diameter downstream, the latter corresponding roughly with the *vena contracta*.

Square-Edged Orifice With Pipe Connections. With an orifice between flanges as before, single-point connections are made in the wall of the pipe at $2\frac{1}{2}$ pipe diameters upstream and 8 pipe diameters downstream from the orifice.

"Diesel"

WE HAVE been searching our memories for a parallel to the use of "Diesel" as a generic name for injection oil engines, and have failed. No one speaks of a condensing engine as a "Watt," or a high-pressure engine as a "Trevithick;" we do not describe the locomotive as a "Stephenson," every steam turbine as a "Parsons," or the self-inductive dynamo as a "Wilde." Why, then, should every internal-combustion engine which happens to compress clean air instead of a charge be called a "Diesel?" Some true Diesel engines are built today. They retain the characteristics of the original design, particularly the injection of the charge by a blast of air compressed by the engine itself. But the type is going out, and by far the greater number of heavy-oil engines now employ pump injection and dispense with the separate compressor which was a feature of Dr. Diesel's design. The majority of them, in fact, have no resemblance to that engine save the compression of pure air, which was invented and used by Ackroyd-Stuart before Dr. Diesel's time. It is true that Dr. Diesel claimed also the high temperature of compression as a means of igniting the charge, but since earlier engines employed automatic or surface ignition with which the timing of the explosion depended upon the compression, the same principle was virtually in use before Diesel adopted it. As a matter of fact, it was the engine itself, rather than the part cycle, which made the inventor's reputation.

We believe the definition "Diesel" has been retained merely as a convenience, though it is known that for a time it had a trading value. In 1922 a committee of the Institution of Mechanical Engineers endeavored to define the various cycles of internal-combustion engines in a convenient form. It found it practically impossible to do so. The phrases became cumbrous and awkward, and none of those that were considered by the committee have come into common use. To get over the difficulty, the word "Diesel" has been retained, but as the progress of invention has taken modern engines further and further from the German prototype, we would urge engineers no less than the general public, to refrain from the indiscriminate use of a word which is not accurately descriptive, and the retention of which does some injustice to a prior inventor. Furthermore, we suggest that it would be a real convenience if the word "Diesel" were retained for those engines, and those alone, using air-blast fuel admission, and that when other means of injection are employed they should be described in some appropriate way—solid injection, airless injection, etc.—but without the use of the word "Diesel."—*The Engineer*, Sept. 5, 1930, p. 256.

Future Aircraft-Design Trends

Trend Toward Cheaper Airplanes Because of Their Greater Safety—Future Production Dependent on Sacrifice of a Certain Amount of Speed, Climb, and Ceiling for Safety

By ROBERT R. OSBORN,[1] GARDEN CITY, L. I., N. Y.

TWO or three years ago, at the height of the boom in aviation, purchasers were actually standing in line and offering bonuses for anything that even looked like an airplane. There was a complete disregard for performance, stability, controllability, and aerodynamic and structural safety. The new operator of the new air line thought that he had only to obtain any airplane and get it into the air to have it begin to make money on his investment. And the private owner thought any airplane would provide him with the sport or transportation he desired. It took just about a year to convince the investor and operator that the airplane business was not different from any other business—that to make a profit required good management and good equipment, and that the inefficient and poor-performing airplane was altogether out of the question. The private owner also discovered that there was a great difference in airplanes, so far as the costs of operating them was concerned and the necessity for frequent repairs and other costly upkeep. Realizing this, there came a demand for performance and efficiency, with a disregard still for first cost, stability, and safety—and by performance was meant useful load carried and top speed.

Unfortunately it has taken a long series of bad accidents to convince us that there is more to be looked for in an airplane than top speed and load carried. The demand has been for speed and more speed. The men in the operating fields have claimed that, as a means of transportation, aviation has only speed to offer the customer, so, if one airplane is not so fast as others, why even consider it for purchase? The designer and manufacturer, who must sell their product to the air line and taxi service and private owner, have had to meet the demand for speed at the sacrifice of all other factors. The fault is not entirely removed from the designer and manufacturer either, as their interests have tended toward great speeds also. There is much more fun and thrill in designing a racer than a truck, and so when it became evident that no one cared about buying trucks anyway, the designer and manufacturer gladly joined in with the chorus demanding speed. The speed was obtained in amazing quantities, but a few other amazing things were discovered at the same time. We found that the most skilful pilots of these fast ships often required two or three "passes" at the large main landing fields before they dared allow their ships to settle for a landing. It became evident to the owner, operator, and especially the pilot that some bad accidents were almost certain to happen in the event of motor failure and a forced landing in a field not so large and not so smooth and well kept. However, as is always the case, nothing was done until the bad accidents did occur, and even now very little has been done to correct this serious situation. The Department of Commerce has done all it can in ruling that it will not license in the future, for passenger carrying, any single-motored ships which land at a speed higher than 60 miles an hour. It is an economic necessity that this ruling should not be made retroactive and force out of production expensive designs which obviously do land at a higher speed under their full load, so the good effects of this ruling have not yet begun to be felt. It is a very wise piece of legislation, and if enforced, should prove a great boon to the entire industry, but its only effect thus far has been to bring out a crop of ships which have (strange coincidence!) landing speeds of exactly 59 miles an hour. There is a definite relation between the lift coefficient of any given airfoil section, the geometric proportions in which it is used, the weight loading on the area, and the speed at which the ship will land, and this fundamental relation is the one which we all disregard so completely. No matter who designed the ship, what manufacturer's name appears on the side, or what pilot is flying it, the ship cannot land below this minimum flying speed. Contrary to what many airplane engineers seem to think, airfoils do not improve with age. A given airfoil will not land an airplane any slower because this is 1930 and not 1920, and if the area is cut down to improve the high speed, there will be no mysterious agency to save the landing speed.

It must be obvious to the air-line operator that he has made a poor investment, even if his ships are fast in covering their routes, if they land so fast that there are frequent minor accidents and some major ones. Aside from the effect these accidents have on the passengers he is carrying, who certainly cannot be expected to continue to use the service if they have been involved in one, they cause costly repair bills and increased investment in equipment and overhead because of the time the ships are laid up and out of service. Further, if his pilots report the ships on his line as having poor stability and controllability, he must know that the first bad weather or blind flying will be the potential cause for disaster. If the ship is aerodynamically unsafe—that is, if it can be spun accidentally, if the lift breaks suddenly on landing, or if the controls are inadequate at any point in the flight range—the operator must realize that at some time even his most skilful pilot can get into serious trouble with the airplane. How often we hear the professional pilot say that he does not need protection from spinning, as he can always recognize the symptoms of a spin in time to prevent it. And yet how often the experienced pilot does fall into an accidental spin in times of emergency—forced landing, bad weather, trying to make a small field and trying to pick up a fading motor; for the first time in possibly ten years of flying the pilot has so many things demanding his attention at once that he does not recognize the incipient spin at its most dangerous altitude. The spin or uncontrolled nose dive following the accidental stall of an airplane is the greatest danger to be overcome in aviation today, and it must be overcome before aviation can progress. The skilled pilot, unfortunately, does not demand aerodynamic safety in the ship he flies, but the air-line operator must place the greatest of value on that feature in choosing his equipment.

Absolute and Unfailing Structural Safety Imperative

The necessity for absolute and unfailing structural safety should be obvious, but we are inclined to take chances with that feature of modern aircraft, too. This does not mean that commercial aircraft should be able to withstand any tricks and stunts the pilot might care to try, as that is an impossibility if we are to

[1] Curtiss Aeroplane and Motor Company.

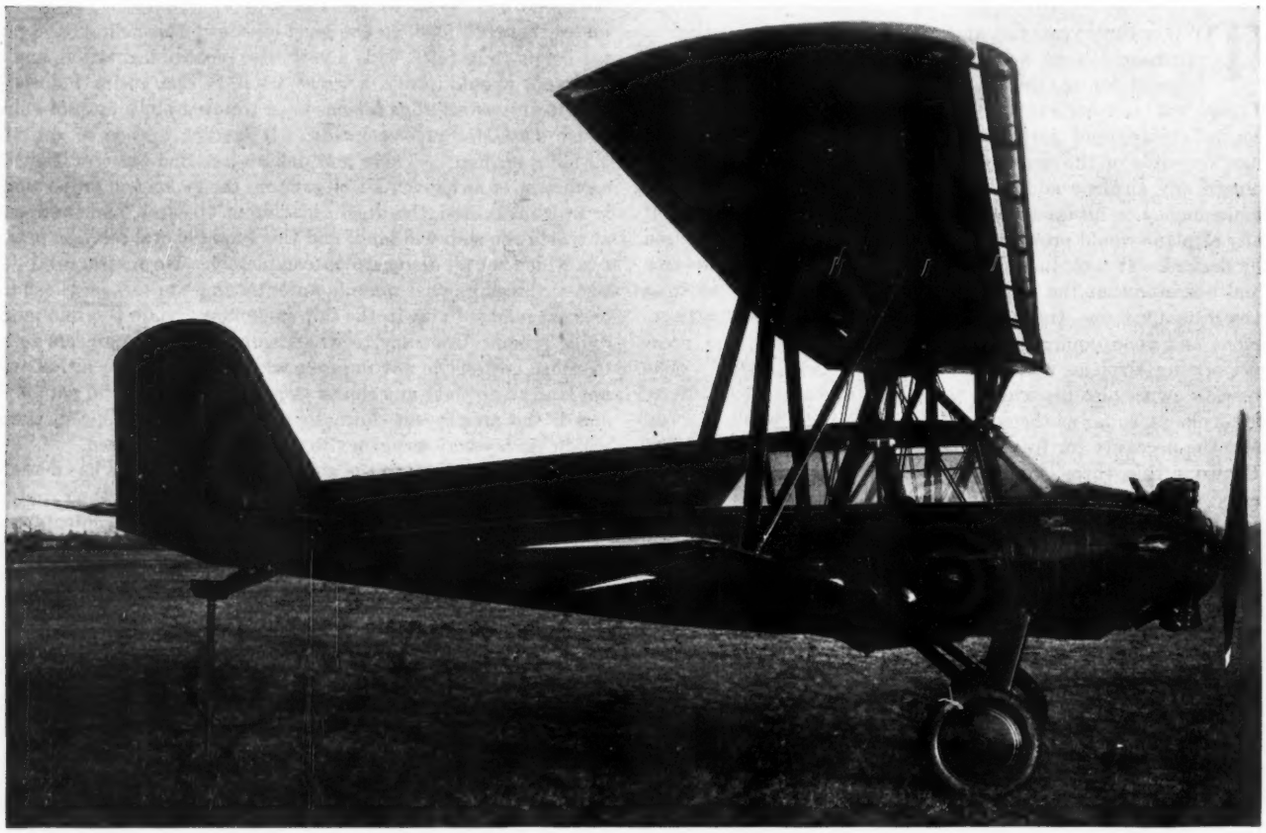
Presented at a meeting of the A.S.M.E. Aeronautic Division with the Chicago Section of the Society, Chicago, Ill., August 25, 1930.

have efficient and paying commercial ships. The safe airplane must be available for use year in and out with only reasonable care and inspection, with no possibility of structural failure. We are inclined to say that structural failure is very rare nowadays, and that no improvement in our structural systems is necessary. Structural failures do occur, however, and are probably the cause of more accidents than we know, and they must be made almost impossible.

Within the last year the thought seems to have struck all of us at once that price is all that is keeping the private owner from buying and preventing the air line from being a financial success. The prices of the airplanes produced for the private owner during the boom period certainly would keep him from buying, no matter what else we had to offer him—no matter how good the airplane was. This is certainly the primary reason why we do not have large private ownership today and why our air lines are losing money, so we can all agree that airplanes must be made cheaper. Any one wishing proof of this need only figure up the costs of maintaining and operating a $7500 to $10,000-airplane, and then realize that such a ship cannot be privately owned by any individual with an income of less than $25,000 a year. A survey of the income-tax returns will then show that there are not very many incomes of that size in the United States. Making further reductions for the number with the required income who will be interested in flying and a still further reduction for the number who will buy the product of any one company, it is easily proved that large production is impossible at those prices. The solution for this part of the problem has been the wholesale cutting of prices, below cost in most cases, and the production of low-powered and cheap power gliders—at least this is the solution offered by most of the manufacturers with large inventories of ships in storage.

Successful Airplane of Future Must Be Both Safe and Cheap

These, then, are the problems to be solved in the aircraft designs of the future. The successful airplane of the near future will not only be fast in top speed, but it will have a slow landing speed, and it will be stable, controllable, aerodynamically and structurally safe, and low in price. It is very easy to make such a statement as the foregoing one, and the reader will recognize it as the same old story he has heard for years and years. However, this paper purposes to offer a solution to these problems, if not the only solution, and not merely to state the problems and say "There ought to be a law," or, "Somebody ought to do something about it all." It sounds trite to say that airplanes must be made safer, but that statement is as true as it ever was, and in the opinion of the author it is the only solution of all of our problems, including those of lower prices and production.



The Curtiss "Tanager," With Slot Flap, and Floating Aileron and 40-M.P.H. Landing Speed

First of all, the successful airplane of the future will be designed by an airplane designer, or a group of them, and not by bankers, salesmen, factory superintendents, or pilots. The days are gone forever when an airplane was designed by a pilot in a barn by the process of welding a lot of gaspipe. When the stability of an airplane was not even thought about, when positions, forms, and areas of controls were guessed at, and the fundamentals of structural design were not even known by the so-called designer of the past, it was only by the greatest of good luck that his product was fit to fly. All airplanes designed by that method will have something seriously wrong with them, and that

condition cannot be tolerated in the future. Not that the designer should be the absolute dictator of the ship he intends to build: the point intended by the first statement in this paragraph is that it must be an experienced designer who coordinates the wishes of every one concerned in the new ship. The banker considers only the profits he wishes to make; the salesmen place too much importance on finishes, upholstery, and equipment; the factory superintendent thinks only in terms of production and ease of construction; and the pilot thinks too highly of high speed and comfort of his cockpit, with hardly a thought to the comfort of the passengers he is to carry. On the other hand, if the designer retires to a corner by himself and turns out a ship without seeking or considering the advice of the others concerned, he develops what is usually an interesting, expensive, and almost worthless airplane. He must find the happy medium to nearly suit the financial, sales, production, and executive groups, who are striving with him to meet the demands of the greatest possible group of customers. When one of these groups has complete control of the design of the entire airplane, then we have a product which is abnormal in one way or another. Only complete cooperation of the entire group will give us the ideal airplane of the future.

SAFE LANDING SPEED MUST NOT BE SACRIFICED FOR HIGH TOP SPEED

In the future, the designer must first select a reasonably safe landing speed, and then obtain whatever top speed he can. The top speed, however desirable, must not be obtained by clipping wing area and sacrificing landing speed. The author's opinion of what constitutes a safe landing speed is 40 miles per hour for the ship which would sell in large quantities to the relatively unskilled private owner, and 60 miles an hour for the taxi ship and transport ship on the air line. The multi-engined airplane capable of flying with partial failure of its power plant is now allowed a higher landing speed, but it is thought that even this should be kept below 60 miles per hour, because of the seriousness of otherwise minor accidents at higher speeds. Even though almost always landing on a good airport, a flat tire or a dragging brake drum can cause a serious accident at higher landing speeds, as can also many other minor mishaps which can be expected to occur continually.

In order that these lower landing speeds may be used to their best advantage, there must be absolutely perfect control at the lowest flight speeds, and there must be no possibility of a spin or uncontrolled nose dive, no matter how carelessly or inexpertly the ship is handled. The use of the floating aileron in conjunction with the automatic slot and controllable flap is the only method today to meet these requirements. Lesser degrees of control can be obtained with a normal aileron and automatic wing slot, and the flap is not essential to the combination except that it gives a still lower landing speed for a relatively small increase in weight and complexity of structure. The full combination, however, of automatic wing slot, floating aileron, and controllable flap is the best way of obtaining the low speed and control, and absolute freedom from spinning and uncontrollable nose dive. Good design of normal controls can make the present airplane difficult to spin, but cannot provide complete insurance against it. Balanced and carefully designed differential ailerons, coupled with an inadequate longitudinal control, may prevent the ship from being stalled in the power-off condition, but it is almost always possible to spin such a ship under power, even accidentally. These devices also serve to simplify the whole control system, which is essential for the private owner and desirable for the professional pilot. When the normal aileron is replaced by the floating aileron, all controls become independent and do not need to be coordinated, and it is well known that coordination is the most difficult part of flying for the student to learn. A well-designed and stable airplane can be flown with floating aileron and elevator alone, eliminating the most dangerous and misused control, the rudder, from being needed by the inexpert pilot.

PLANE WITH SLOT, FLAP, AND FLOATING AILERON AND 40-M.P.H. LANDING SPEED SAFE

If we use the slot, flap, and floating aileron and also hold the landing speed down to 40 miles per hour, we can then have an airplane which can be safely flown by a pilot with a complete lack of depth perception. He will not have to swish the airplane to within a few feet of the ground at a speed somewhat above the stall before he allows it to settle for a landing. With the limitations given, the vertical velocity of fully stalled flight is small enough so that the shock can be absorbed by a reasonable-sized landing gear. The pilot of such a ship would then have only to point his ship into the wind at any height over the airport, shut off his engine, and stall the ship and hold it stalled. It can be designed to be stable enough so that no controls need be operated, and the airplane will effect a good three-point landing all by itself. This is not just idle speculation on possibility; the Curtiss "Tanager," which won the Guggenheim Safe Aircraft Competition, would actually do this. While on its exhibition tour the pilot repeatedly "landed" it at heights up to 3000 ft., simply holding the stick all of the way back until the ship landed itself. This method of landing could also be used if the motor failed on take-off, which is another very dangerous point for the inexperienced pilot. Flat turns could be made with the rudder held hard over at full stall with no loss of control. Most important of all, the ship could not be spun or put into an uncontrolled nose dive. It would recover by itself, with all controls free, from violent disturbances, with a loss of height not exceeding 500 ft. and with almost no loss of height if the controls were used. It was unfortunate that the Guggenheim Safe Aircraft Competition came to an end at the same time that the business depression began, as the good results it is going to have will be delayed just that much longer. Mr. Guggenheim has made a great contribution to the art of aeronautics, but we must wait a few years for the good effects of his missionary work to be really felt. It was absolutely proved that it is impossible to build a safe airplane, as defined herein, without the use of slots, flaps, and floating ailerons. Only one ship passed the minimum requirements of the Guggenheim Fund, and the only other ship which came near passing was fitted with slots, flaps, and normal ailerons. There were eighteen tests in all, and no ship fitted with normal wings could pass even the first test, a high speed of 110 miles an hour, nor could they pass the low-speed requirement either, a gliding speed of 38 miles an hour.

These devices will not add to the high speed of the airplane on which they are used, nor will they detract from it very much. The high speed of the Curtiss "Tanager" was within three miles an hour of the high speed of accepted commercial monoplanes using the same motor and carrying the same useful load. The monoplanes landed at 55 miles an hour instead of 38. The climb and ceiling will also be less than for a ship of the same area using normal wings, as the slot-and-flap wing is necessarily heavier. However, we can obtain an 85 per cent increase in lift for 40 per cent increase in the weight of the wing group, consequently great improvements in the landing characteristics can be realized by the use of these devices. If by performance is meant high speed, then the slot, flap, and floating aileron interfere with performance. If the more liberal and safer interpretation of performance is used, then we can say it is very much improved by their use. In any case they are absolutely essential if airplanes are to be handled by more inexperienced and

inexpert pilots. This brings us naturally to the point which is of greatest interest to all—greater production and cheaper airplanes.

AIRPLANES MUST BE MORE EXPENSIVE BEFORE THEY CAN BE CHEAPER

It is a great fallacy to assume that it is only cost that is keeping the private flier from purchasing, and that by simply cutting costs below production expenses, greater production can be obtained which will justify a lower sales price. This will work temporarily until the cheaper airplanes have been provided for all who have the physical and mental qualifications necessary to fly them, but the production limit will be at that point. Production will be increased, but the greater potential number of airplane users will not be affected in the least. The modern automobile would not be the splendid and low-priced machine it is today if the highest order of mental and physical skill were required to drive it. At the beginning, a high order of skill was required; and the automobile driver was held in as much awe at the begining as the airplane pilot is today. However, the automobile has been continually improved, simplified, and made safe, until today it can be driven relatively safely by any one with ordinary intelligence. The production expert on airplanes holds up his hands in horror at the suggestion that greater production could be obtained if slots, flaps, and floating ailerons were added to an airplane. They are unquestionably expensive to build, but the same can be said of four-wheel brakes, foot accelerators, automatic spark control, automatic radiator control, and shatterproof glass as used in the modern automibile. These obviously would not be added to the automibile if they did not pay for themselves in added production. We do not have and never will have a sufficient number of private owners with the required skill to fly the modern airplane in great quantities. There are not enough people with the physical qualifications, the desire to fly, and money enough to go through with the present protracted flying courses to give us anything approaching quantity production, no matter how cheap airplanes may be. Paradoxically, the airplane must be more expensive before it can be greatly cheaper. To get real production we must tap a greater source of buyers. The airplane must be made safer and easier to fly before it will be available to the private owner in great quantities.

SUMMARY

So, to sum up, the design trend in the future will be toward cheaper airplanes because they are safer airplanes. The fact that an airplane will be reasonably cheap in first cost and can carry a good load at high speed will no longer be all that is required. The airplane which will be sold in real production in the future will sacrifice a small part of its possible high speed, climb, and ceiling for safety. It will be stable and controllable throughout the flight range. It will be structurally safe, and there will be no possibility of failure if reasonable care and inspection are practiced. Most important of all, it will be aerodynamically safe, with no possibility of an accidental spin or uncontrolled nose dive. The landing speed will be low, within safe and reasonable limits. With that type of ship we shall have the private owner learning to fly in little more time than it takes him to learn to drive his car, and with only slightly higher physical and mental requirements. With a similar ship, but with a greater allowance for the skill of the pilot, we shall have air lines safely flying great numbers of passengers, and with the probability that operations will be on the black-ink side of the ledger

---

Flying From the Private-Owner's Standpoint

BY EARLE OVINGTON,[1] SANTA BARBARA, CALIF.

WHY are there so few private owners of airplanes? Because the airplane really suitable for the private owner has yet to make its appearance.

Aviation is at this very moment before the bar of public opinion, and what is done within the next two or three years will largely determine the progress it will make in the next ten. Particularly at this psychological moment, we who are interested in this great new development have much to gain from frank discussion and friendly criticism.

The main reasons why the private owner is not a factor in aviation today are that private flying is too dangerous, caring for the ship takes too much time, and the expense is too great for the average pocketbook.

OBJECTIONS TO PRIVATE FLYING

Dangers. Without question, flying under the right circumstances is relatively safe when compared with other high-speed methods of locomotion. On a schedule air line the circumstances usually are "right." The pilot is well trained, his experience has been extensive, the plane is the best obtainable, its mechanical condition is everything that could be desired, the airway is well known to the pilot, emergency landing fields and airports are usually frequent along the route, and undue risk is not usually taken on account of weather conditions.

In private flying the pilot is often not well trained; his experience is often inadequate in spite of the fact that he must pass the Department of Commerce tests in order to get his license; his ship, so far as design and construction are concerned, does not always compare favorably with the large air transports; its mechanical condition, owing to the fact that the private owner does much of his own work, is not always what it should be; and the private owner does not, as a rule, follow an airway, with the result that landing fields and service stations are not always convenient. Only when it comes to weather conditions is the private owner better off than the air-transport pilot; the pri-

[1] Owner, Ovington Airport, Santa Barbara, Calif.; Mr. Ovington received the degree of E.E. from Massachusetts Institute of Technology in 1904 and is also a graduate of the Blériot School of Aeronautics, Pau, France. He holds the commission of Lieutenant-Commander in the U. S. Naval Reserve. He is president of The Early Birds, a member of the Quiet Birdmen, the National Air Pilots' Association, and the Progressive Pilots' Association. He was the winner in 1911 of the Boston *Globe* Tri-State Air Race and $10,000, as well as the John R. McLean Trophy of $2500. He was the first U. S. Air Pilot (1911) and holds a transport pilot's license. Lieut-Comdr. U.S.N.R.

Presented at the Seattle Aeronautic Meeting of the A.S.M.E. Aeronautic Division, Seattle, Wash., May 22–23, 1930. Abridged.

vate owner is usually a fair-weather pilot, and largely avoids weather risks.

If private flying is to be safe as compared with air-transport flying, the ship of the private owner must be as near foolproof as it is possible to make it. And there is not a single ship on the market today that I know of—and I have flown most of them—which can be put in this class by the greatest stretch of the imagination. The Curtiss "Tanager," winner of the $100,000 Guggenheim safe-airplane competition, is a big jump in the right direction, but even its designers and makers do not claim that it is the ideal ship for private flying; besides, it is not on the market.

Care of Ship. An airplane is a nuisance to take care of, compared with a car. It requires far more servicing and more careful servicing, and, unlike a car, it must have proper servicing if it is to be at all safe.

In order to give you a more exact idea of the servicing required by even a small airplane, let me tell you just what I do *after every flight* from my home port in my own ship.

First, I clean the oil from the ship which has been thrown over it by the engine; and I must do this soon after my return before the oil gets gummy. With a rag soaked with aviation gasoline in one hand, and a clean (comparatively) rag in the other, I go to it; and when through, I must wash my hands in gasoline to get them anywhere near clean.

Second, I remove the cowling from one side of the ship just behind the engine in order to carefully examine the gas and oil lines, as a dangerous accident might result from the failure of either. And while the cowling is off, I take occasion to give that portion of the ship the general "once over," often tightening nuts loosened by engine vibration.

Third, I drain the sump of the gasoline strainer, and invariably find dirt and often water in the line. This operation, however, only takes a short time and will always have to be done in connection with servicing an aviation engine.

Fourth, and this is a big nuisance in airplane servicing, the valve clearances must be checked. Having a seven-cylinder motor, that means no less than fourteen valves to check after every flight. This would not, of course, have to be done after every flight if merely hops from the airport were taken, but my flights are always of longer duration, averaging about seven or eight hours. Incidentally, never in my experience of twenty years in checking valves but what I have had to make some adjustment to the clearances. How much automobiling would be done if one had to check the valves every ten hours or less?

In addition to the above regular routine after every flight, there is other work to be done to keep an airplane in good flying condition.

About every fifteen hours, or even more frequently, the oil must be drained from the engine, the oil strainer cleaned, and new oil put in the tank. When I change the oil, I usually also oil the magnetos and grease the rocker arms—fourteen of them. Incidentally, it is surprising how thoroughly the rocker arms distribute grease over an airplane. Eventually most of it gets out of the rocker boxes in that manner.

Every twenty-five or thirty hours I go over every nut on the engine, and usually find quite a few that need tightening. Now it so happens that most of these nuts are castellated and fastened with cotter pins, and one might think that they would never get loose; but they do, often because they hold down parts separated by elastic packing which shrinks and allows the nuts to loosen.

After the engine has been checked, I go over all of the controls, being sure that no wires are frayed, the pulleys revolve freely, oil is where it should be, and that no cotter pins are missing. It only takes one failure of the controls in an airplane to make you a member of the famous "caterpillar club."

The shock absorbers may need attention; the wires of the ship are "thumbed" to see if they are at the right tension; the tires may have to be pumped up; and almost always the gas tanks need refilling. In a private hangar, by the way, this usually means putting in five gallons at a time, balancing on the wheel of the plane while you lift the five-gallon can full of gas up to the funnel in the wing tank.

The airplane needs much more servicing than the automobile; and the country is not dotted with service stations for airplanes as it is with car stations. Incidentally, even if it were, the expense would be great to service a ship as compared with a car.

Expense. An airplane costs more to buy than a car for a given grade of vehicle, and it costs more to operate than does a car of the same class.

An airplane engine is expensive, and comparatively more delicate as compared with the power plant of a car. The parts are more expensive and they need more frequent replacement; and the motor requires far more servicing than does the automobile motor.

The finish and fabric of an airplane are not so durable as those of a car. When all-metal airplanes are the rule rather than the exception, the situation will be reversed.

So far as mechanical simplicity is concerned, the airplane has the advantage over the car and ultimately will, without question, be as cheap or cheaper. But at the present time the airplane does not compare favorably with the car in the matter of expense, either in first cost or in operation.

Changes Needed to Make Private Flying Safe

Visibility. Visibility on the ground, while taxiing, as well as in the air, is the one characteristic which is lacking in practically all of the small airplanes on the market. With the engine in the nose of the ship, as it is in practically all of the small airplanes of today, the pilot is about as blind as the proverbial bat. But why put the engine in the nose? The visibility is much better if you don't.

Motors. Practically all motors are dirty, some dirtier than others. I have never seen one that did not throw more or less oil and grease.

Radials do not streamline in well on the nose of an airplane. Not only does this enormously increase the parasite resistance of the airplane itself by the air eddies created by the engine, but a lot of engine power goes to overcoming this unnecessary head resistance. The N.A.C.A. cowling has helped on certain types of airplanes, but this cowling is not suited to other types and at best it is a makeshift.

The visibility behind a radial is comparatively poor, particularly if fitted with a N.A.C.A. cowling.

Personally, I should like to try a six-in-line inverted motor, air cooled, of course. A good six-cylinder car engine is smoother than any radial I have ever flown behind; and they don't throw oil and grease. Furthermore, the visibility behind such a motor would be all that one could expect with the engine in the nose of the ship.

Landing Speed. There is no more important aerodynamic problem before the airplane designer today than increasing the distance between the cruising speed of the airplane and its landing speed; in other words, reducing the landing speed while keeping the cruising speed at a fair figure.

A wing whose characteristics may be changed in the air, at the will of the pilot, holds great possibilities. In a way, this is just what is done with the "Tanager" by means of its slots and flaps, but in rather of a crude way, the airfoil shape with the slots and flaps out being very inefficient. Before long I believe it will be possible to have a high-speed airfoil for cruising and

top speed, and a very much lower-speed airfoil for rapid take-off, sharp angle of climb, and low-speed landing. The mechanical difficulties are great, but with the well-recognized need for such an arrangement, and the large number of competent engineers now working on the problem, it is only a question of time when such a device will be forthcoming.

Stability. Good inherent stability is, without question, highly desirable in any airplane, but particularly so in the ship designed for the private owner. But stability must not be obtained at the sacrifice of maneuverability.

Ultimately, I am convinced that a ship will be evolved having wings with such a flat burble point, and with such a high lift at low speeds, and so stable inherently, that when the pilot wishes to land it will only be necessary to pull the stick back as far as it will go and permit the ship to literally land itself. On a large field I believe this is possible with the "Tanager," and I have flown another make of ship where an approach is made to this desirable condition.

NOISE

Just as the first automobiles were noisy until the public demanded that they be noiseless, so it is with airplanes. The airplane suffers in this regard compared with the automobile because the propeller of an airplane makes a noise over which there has so far been little control. But in our efforts to win the public over to aviation we should not overlook this question of noise, both from the standpoint of the occupants of the ship and the people on the ground.

COST

I am not one of those who believe that the average man does not fly because of the cost. I know of many to whom cost is of no importance who often fly as passengers, but who consider flying too dangerous for them to personally attempt. They are good car drivers, but flying the small ship of today is, from a safety standpoint, just a little too much of a risk. Primarily, this may be because many of those I have in mind are men over forty years of age; they have reached an age of discretion. Incidentally, they are usually the ones who have the money.

Regarding the cheap air "flivver" about which we hear so much talk, and bearing in mind the weak points in the modern small airplane, I see nothing to be gained, and much to be lost, by flooding the market with cheap ships and the introduction into aviation of a large number of careless and inexperienced fliers.

SERVICING

Until the private owner can keep his airplane in good flying condition without spending an hour tinkering on the ground for every hour spent in the air, we cannot hope to seriously interest the average man in flying and owning his own ship. He has been given relatively care-free transportation in automobile, and will expect it in the airplane. Until we give it to him, we cannot expect him to join our ranks as a private owner. Along this line I wish to make the following suggestions to aircraft and engine designers:

Make every part of the engine as "getatable" as possible, bearing in mind that it is merely a piece of machinery and must be frequently adjusted or repaired.

Standardize the bolts and nuts, and reduce their number to a minimum; and send a tool kit out with the engine containing tools to make any adjustment which may be required.

Have no exterior oil lines. Can you not even incorporate the oil tank with the engine crankcase in order to eliminate messy oil lines and do away with the separate oil tank? That's one point where the old OX-5 won out over the modern engine.

Entirely enclose the valve mechanism in an absolutely oil-tight case, thus eliminating most of the oil and grease throwing of the present-day engine. Incidentally, this absolutely protects these parts from dust and grit.

Fit as standard equipment some form of air cleaner, or take the air through a duct opening above the cowling; or possibly employ both methods. It's a crime to take the air from beneath the engine, laden with dirt as it always is when the ship is warming up on the ground.

Make the engine cowling easily removable and replaceable; and make it in fairly small sections so that portions only may be removed at a time.

Supply an electric oil heater as standard equipment. It's nonsense to have to wait fifteen minutes on a cold day warming up the engine under its own power; and it's costly to run an expensive engine for such a purpose, particularly as the wear is greater when the oil is cold.

Place convenient handholes in the cowling so that the gas and oil draincocks may be easily reached without removing part of the cowling. And have the cocks closed when the handle points downward, as this is the position that vibration tends to make them assume.

Use lock washers whenever practicable instead of castellated nuts and cotter pins.

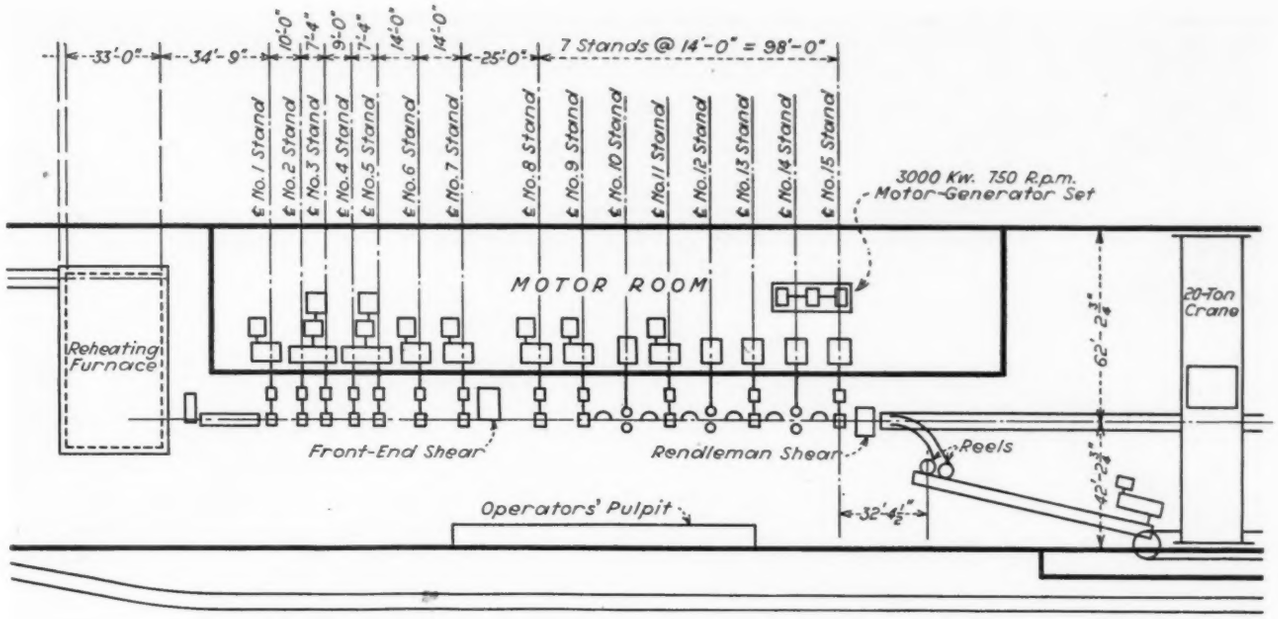
In general, do everything possible to reduce the amount and frequency of servicing required on both engine and airplane.

Magnesium Alloys

MAGNESIUM-alloy sand castings of high quality are being regularly produced. The foundry methods require careful control, but are quite suitable for large-scale production. Castings are not difficult to make, and they have the advantage that they are practically free from "pinholing."

Magnesium is not one of the easiest metals to work; it belongs to the hexagonal system, the crystals of which are liable to be brittle when stressed in certain directions, and considerable care is required in working. Sheets and extruded sections are being produced in considerable quantities and are finding many applications. Forgings are also being successfully produced, but there are still problems to be solved before complete success can be regarded as achieved in this direction. The working range of temperature is short—420 deg. to 450 deg. cent.—and the working tools must be kept rather hotter than the work; slow working is best, and the press is preferable to the hammer.

There are two directions in which magnesium is inferior to aluminum: its elastic modulus is less in about the same ratio as its specific gravity, and saving in weight is therefore sometimes only possible at the expense of rigidity. For many applications this is unimportant. On the other hand, in such instances magnesium alloy will often give greater strength for the same rigidity. The second disadvantage is in regard to corrosion; this is only serious in regard to sea-water corrosion, and even in this instance has been much exaggerated. The present-day alloys are much better than their predecessors, partly because of better methods of manufacture, partly because of suitable alloying. The methods of working have also been found to have an influence, and further improvements may be expected when these are more developed. Moreover methods of protection such as have lately been devised for aluminum, by anodic oxidation, metallic coatings, and varnishing, will doubtless be devised also for magnesium alloys. The great corrodibility of steel in saline solutions has not prevented its use in seaplanes, and protective measures are accepted here as a matter of course; the case of magnesium will doubtless be similar.—Prof. D. Hanson in a paper before the Institute of Metals. Reprinted from abridgment in *The Engineer*, Sept. 12, 1930, p. 293.



General Layout of the Inland Steel Company's New Merchant Mill

The Inland Steel Company's New High-Speed Merchant Mill

A MERCHANT MILL, that is, a mill rolling a variety of simple sections, such as squares, ovals, etc., is probably one of the oldest forms of mills. It is known in different countries under a variety of names, such as a guide mill (which is, however, more applicable to the type of merchant mill that rolls rounds), hoop mill, iron mill, combination mill, etc. The earliest type of merchant mill consisted of a single stand of rolls driven in one direction only, a type which is today retained in this country practically only in the hot sheet mill. The early merchant mill had no guides at all, and the roller guided the bar by means of tongs. The piece was returned by the catcher over the top roll just as is done in sheet mills today. It was only natural to add a third roll, making the mill a "three-high," so as to roll the bar both ways. This saved time and labor, which was important in view of the small weight of the piece rolled.

Even with this addition, however, only comparatively short lengths could be rolled, and the material had a tendency to chill quickly. The next step was the introduction of the so-called Belgian or looping mill, in which the piece could go through several two-high stands of rolls at once. As the stand head handled a longer piece, its speed was somewhat greater than that of the preceding stand, but not great enough to maintain the metal in tension, which meant that a loop of metal between stands was permitted.

This was succeeded by a method of rolling which was divided into two operations: roughing or breaking down from the original bar, which was done on a three-high mill; and finishing, where long lengths of comparatively slender material were handled in the Belgian mill. From this to a continuous mill where the bar entered the first stand from the reheating furnace and was finished without leaving the mill, was only a logical step, and was greatly facilitated by the fact that the introduction of electric drive made the control of speed of the individual stands comparatively easy.

TABLE 1 SPEEDS OF ROLL STANDS WITH A 2:1 SPEED RANGE OF MOTORS AT FULL VOLTAGE OF GENERATORS

(Generators are arranged to give additional speed ranges below the full-voltage low speed of motors)

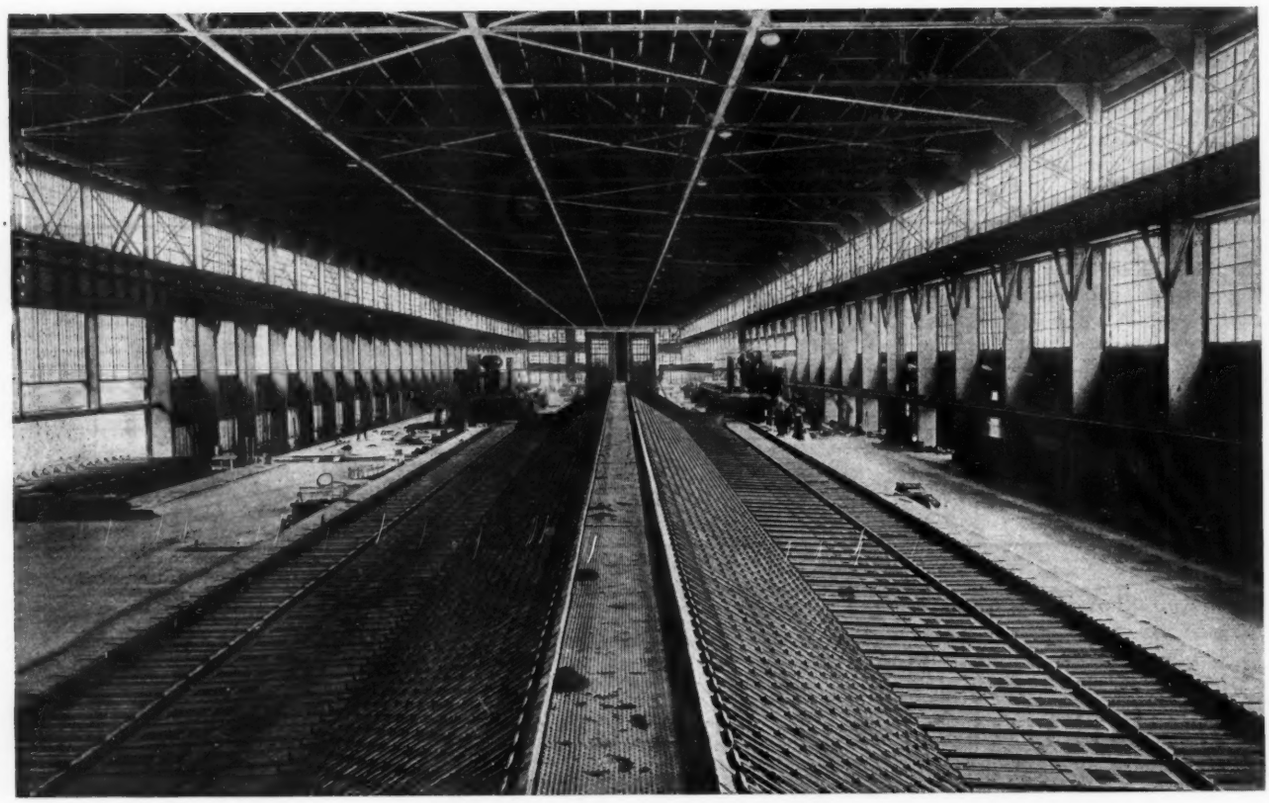
Stand No.	Pinion pitch	Length of rolls, in.	Speed of motor, r.p.m. Min.	Speed of motor, r.p.m. Max.	Speed of stand, r.p.m. Min.	Speed of stand, r.p.m. Max.
1	14	28	400	800	15	30
2	14	28	400	800	20	40
3	14	28	400	800	27	54
4	14	28	400	800	35	70
5	14	28	400	800	45	90
6	14	28	400	800	58	116
7	14	28	400	800	72	145
8	12	24	400	800	105	210
9	12	24	400	800	130	260
10 vert.	12 1/2	18	400	800	175	350
11	12	24	400	800	222	444
12 vert.	12 1/2	18	400	800	270	540
13	10	18	400	800	400	800
14 vert.	12 1/2	18	400	800	330	660
15	10	18	400	800	400	800

A compromise between the continuous and non-continuous mill may be mentioned here. It is represented by the so-called "cross-country" mill in which the material is moved from stand to stand, but the distance between the stands is such that the material is at no time in two hands simultaneously. This is resorted to in the case of material that does not lend itself conveniently to looping.

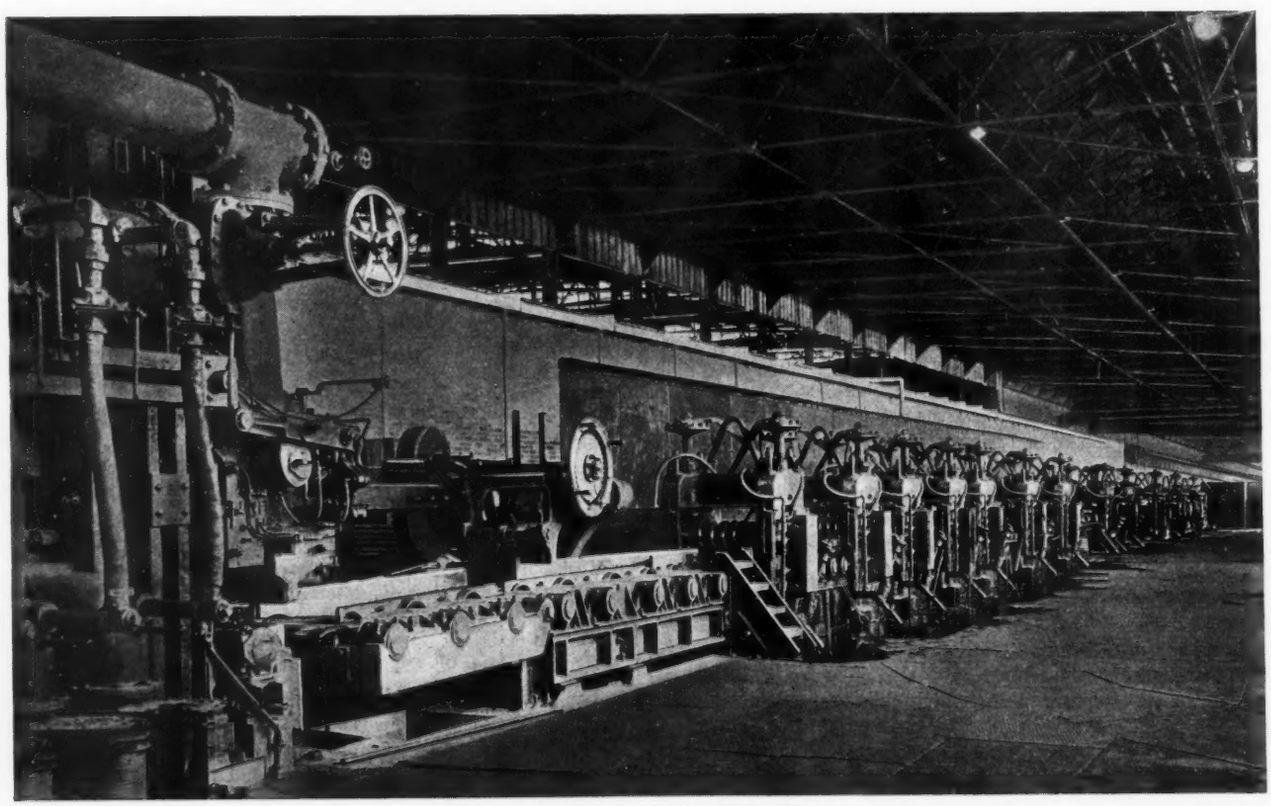
Mill of the Purely Continuous Type

The Inland Steel Company's new mill at Indiana Harbor, Ind., is of the purely continuous type, and is interesting as representing the latest ideas in this type of equipment.

There is a vast difference between an old merchant mill and such an installation as that now operated by the Inland Steel Company at Indiana Harbor. This mill opened for business on August 1,

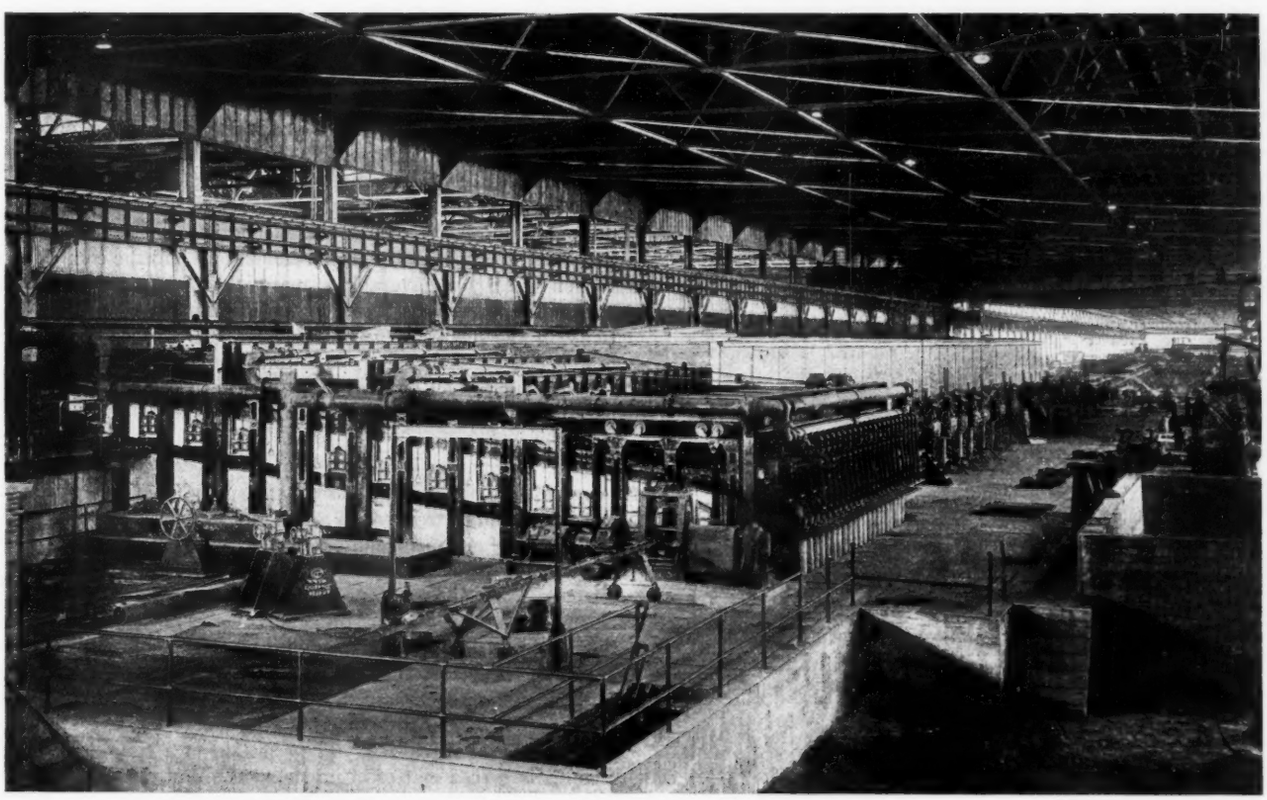


VIEW ALONG THE HOT BED SHOWING THE OPERATOR'S PULPIT AND SHEARS AT THE FAR END



VIEW SHOWING THE 15 STANDS IN A LINE

VIEW SHOWING THE SHEARING EQUIPMENT, GAGES, AND SCALE CRADLES



VIEW SHOWING BILLET-HEATING FURNACE WITH THE MILL AND MOTOR ROOM IN THE BACKGROUND

1930, and is an enormous structure nearly half a mile long, beautifully lighted, high, clean, and, considering the work done, remarkably lacking in dust and noise. From an engineering point of view the mill comprises certain features which, while not in every case novel, are well worth attention.

ENGINEERING FEATURES OF THE INSTALLATION

The raw material for the mill is prepared in another part of the plant and consists of $1^{3}/_{4}$-in.-square stock. This is brought in and delivered to a reheating furnace where it goes in at the side of the furnace and comes out at the other, being pushed through by electrical machinery.

From the furnace the stock goes into the mill proper which consists of fifteen stands, of which twelve are of the usual horizontal type and three, Nos. 10, 12 and 14, are vertical. Contrary, however, to the standard practice, these vertical stands are not edging stands but actual working stands.

Stands Nos. 2 and 3, 4 and 5 are driven as pairs by individual motors. All the other stands have each a motor to themselves. These motors are all shunt-wound direct-current machines and are supplied with power from two motor-generator sets, the arrangement being such as to permit quite flexible control of the motors cut in on each of the motor-generator sets. The speed of the motors is controlled by varying the field voltage, and the rolls are driven through reduction gears. The relation between the motor speed and the speed of the roll stands is shown in Table 1. The motors are all housed in a building of their own, which is roomy, well arranged, and very clean. In fact, even the air in the motor room is artificially cleaned. The drive is through gears, with a shaft going through the wall of the motor room to the mill proper. The roll beds are equipped with individually driven rollers, but here, instead of direct current, alternating current is used for the drive, the speed of the rollers being controlled by changing the frequency. On the whole, the speed of the rollers is somewhat in excess of that of the roll stands, so as to give a slight amount of slip.

The roll stands from No. 1 to No. 8 are set very close together, although it must be remembered that this is not a continuous mill of the tension type and that loops are permitted between the stands. Of course, as the metal goes through each of the stands it elongates, which means that each subsequent stand has to be driven at a higher speed, with a tendency for the loop to enlarge. The last stands, beginning with No. 9, run at a very high speed, and because of this it is desirable to permit the loop to become quite large. In order to prevent the metal from excessive stretching, whipping, etc., gates controlled from the pulpit are provided. As each of the loops forms, the gates open to make room for it, and when the piece runs through, the gates crash shut. The whole operation is controlled by two men in the pulpit.

When the material comes out from the mill it can either go on to the hot bed, passing through shears, and from there after being weighed can be sent out for shipment or future processing, or it can go to the coil conveyor. The latter has been installed, but has not yet been run.

Physical Properties of Non-Ferrous Metals

THE relation between strength and lightness in the different materials can best be expressed by dividing the mechanical properties by the specific gravity; the strength properties may be represented by the ratios: maximum stress/specific gravity: proof stress/specific gravity: fatigue range/specific gravity, and so on, while the rigidity comparisons are obtained from the ratio—Young's modulus/specific gravity. Some of these properties are set out in Tables 1, 2, and 3, for some typical strong aircraft materials.

TABLE 1 SPECIFIC TENACITIES FOR VARIOUS STRONG AIRCRAFT ALLOYS

Material	Maximum strength, tons per sq. in.	Specific gravity	Specific tenacity
Steel	50	7.8	6.4
Nickel-chromium steel (heat-treated)	90	7.8	11.5
Stainless steel (austenitic, cold-worked)	65	7.8	8.3
Duralumin	26	2.8	9.3
Duralumin (cold-worked)	30	2.8	10.7
Elektron VI, magnesium alloys (heat-treated)	22	1.8	12.2
Monel metal (cold-rolled sheet)	56	8.8	6.3

TABLE 2 SPECIFIC PROOF STRESSES FOR VARIOUS STRONG AIRCRAFT ALLOYS

Material	Proof stress, tons per sq. in.	Specific gravity	Specific proof stress
Steel	40.0	7.8	5.1
Nickel-chromium steel (heat-treated)	65.0	7.8	9.3
Austenitic steel (cold-worked)	50.0	7.8	6.4
Duralumin	16.5	2.8	5.9
Duralumin (cold-worked)	22.0	2.8	8.0
Magnesium alloy, Elektron VI	14.5	1.8	8.1
Magnesium alloy, Elektron AZM	11.0	1.8	6.1

TABLE 3 SPECIFIC MODULI OF SOME STRONG AIRCRAFT MATERIALS

Material	Elasticity, tons per sq. in.	Specific gravity	Specific modulus
Spruce	670	0.45	1.490
Steel	13,000	7.8	1.667
Duralumin	4,600	2.8	1.643
Magnesium alloys	2,790	1.8	1.550
Nickel alloys	13,800	8.8	1.570

The comparison is interesting and shows that there is a remarkable uniformity between the high-tensile steels, the best aluminum alloys, and the best magnesium alloys at present available in regard to all these qualities, although the absolute values for the different properties differ greatly from one another. In regard to rigidity, the figures apply to parts used in tension or compression; under transverse or bending stresses rigidity depends also on the moment of inertia of the section, which increases rapidly with the linear dimensions, and the comparison is then much more favorable to materials of low density.

Structural theory is based on the assumption of perfect elasticity in the materials used. Under actual service conditions, however, some slight deformation must be anticipated, although this must naturally be kept very small. In order to define the resistance of a material to permanent strain, the term "proof stress" has been used; this is the tensile stress at which the plastic deformation is one-tenth of 1 per cent, and this figure, or something rather less, is used extensively for design purposes as the maximum stress which a material will withstand.

The case of members required to resist pure tension is relatively simple, and the lightest material is that with the highest specific tenacity or specific proof stress. For highly stressed parts of this nature, high-tensile steel, preferably nickel-chromium steel in the hardened and tempered condition, is the lightest material available. Any thin rod or flat sheet possesses an inherent lack of rigidity and becomes unstable in shear or compression, and is liable to fail by buckling or crumpling before the true strength of the material is realized. The selection of a suitable form of member is here a matter of importance.—Prof. D. Hanson in a lecture before the Institute of Metals; reprinted from abridgment in *The Engineer*, Sept. 12, 1930, p. 291.

Combustion Radiation and the Planck Quantum Theory[1]

By WALTER J. WOHLENBERG,[2] NEW HAVEN, CONN.

In the parts of this paper published in September the author explains briefly the Planck quantum theory and shows that the quantum of energy is fixed by the Planck constant and the frequency of the radiation wave. While many applications of the theory have been made by scientists, neither scientist nor engineer, in so far as the author is aware, has ever applied it to evaluate the particular radiation that is emitted from atom groups entering to form product molecules during the combustion reaction as occurs, for instance, in the boiler furnace. Without resorting to mathematical analyses unfamiliar to the average engineer, but using the method of statistical mechanics and the second law of thermodynamics, the author shows that the frequencies of the quanta emitted from the reacting groups of atoms must, for all but a negligible part of the total radiated energy, fall within the infrared or heat-wave range. The October instalment discussed the laws of energy distribution and the distribution of energy of combustion radiation.

IV—THE ENERGY PROCESS IN THE INTERIM BETWEEN THE BEGINNING AND THE END OF A REACTION

Early in this paper the point of view was expressed that whatever happens in any process, whether it may be observed or not, must be in accord with the second law of thermodynamics. It is from this point of view that the possible modes of procedure in the time interval between the states T and B, which represent, respectively, the beginning and end of the combustion process, will be investigated.

For convenience in discussion the energy released by an atom group which enters a reaction to form a product molecule is stated as follows:

$$\Delta e_B = (e_T - e_B) + e_C$$

and

$$\Delta e_x = (e_T - e_x) + e_{Cx}$$

in which, as previously noted, e_T is the energy due to the thermal state above some reference plane, e_C that which may be released in this thermal state by chemical reaction, and e_B that which remains in the product molecule in the form of thermal energy. The subscript x refers to any state under consideration.

Inspection of the expressions for Δe_B and Δe_x shows that a release quota Δe_x could be unusually large with respect to a quota Δe_B if—

1 The thermal-energy quota e_T of the atom group which enters to form the product molecule should be unusually large and the other coordinates retain the magnitudes of end state B;

2 The thermal quota e_x of the product molecule of state x should be unusually small and the other coordinates retain the magnitude of end state B; and

3 The potential chemical energy e_{Cx} of atom groups combining to form the product molecule of state x should be unusually large as compared to the potential chemical energy e_C associated with the atom groups which enter to form the final product molecule of state B.

Conditions 1, 2, or 3 in each case imply certain assumed macroscopic conditions for the interim state x of the energy which must exist if the condition is to exist. These assumed conditions might then be said to be valid in a degree measurable by the probability that the coordinates e_T, e_x, e_B, Δe_B, and Δe_x may have the values required under the assumption. This probability is dependent on two conditions. First, it is a function of the macroscopic state of the energy existing in the atom and molecule mass at an instant just preceding its discharge into the furnace cavity. Second, it is a function of the energy control exercised by the atmosphere of the furnace cavity on the atom groups entering the reaction after they are in the furnace cavity.

Consider the probability of the existence of the first of the foregoing conditions which make it possible to release an appreciable portion of ΔE in unusually large contributing quota Δe_x. This condition really prescribes for the atom groups per product molecule, which are to release such quota, initial energy quota e_T which shall exceed the initial energy quota e_T of other like atom groups by the amount by which the large release quota Δe_x shall exceed the mean release quota Δe_B. The greatest differences which could possibly exist for the coordinate e_T in the various zones of the furnace cavity are fixed by the differences in magnitudes of the potential chemical energy coordinate e_{Cx} in these zones. Before this energy is released it takes no part in establishing the macroscopic energy control which is exercised by the energy atmosphere of the furnace cavity on the atom groups contained within it. It is thermally isolated during this period, but the instant of its release is the instant of its transfer from chemical energy in thermal isolation to thermal energy under thermal control. But the influence which its release exerts to build up a difference in energy levels between the host group of atoms from which it has emerged and neighboring groups or molecules which it is in a position to see, is held in check by the radiation which proceeds from these hosts of higher quantum levels to other molecules of lower quantum levels. By this radiation the quantum levels of all of the host groups are reduced and those of other atom groups or molecules are raised so that a time mean level of the energy in the furnace atmosphere is established which, for all but a negligible part of the total energy involved, inevitably forces the host atom groups to retain as thermal energy a considerable fraction of the released chemical energy e_{Cx}. Thus only a small part of the total energy involved can actually be exposed to differences in energy levels equivalent to the total value of the release quota Δe_x. This is true unless for a considerable fraction of the released energy each quota Δe_x is emitted as a single quantum of radiation. It will be shown later that this is the least probable of all of the ways in which the release quota Δe_x may be divided into quanta. It follows that the maximum variation in the initial energy quota e_T can be, for all but a negligible fraction of the total energy involved, no greater than fractional parts of the mean magnitude of the release quota Δe_x, and therefore, in so far as variations in the contributing thermal quota e_T are a cause, only a negligible portion of

[1] Continued from the October issue.

[2] Sterling Professor of Mechanical Engineering, Yale University. Mem. A.S.M.E.

the total released energy ΔE may be furnished in release quota Δe_x which differ from the mean value of this quota by more than a fractional part of its mean value.

The thermal-energy control described for the quota e_T within the furnace cavity is obviously universal and applies to all thermal energy within this cavity. Therefore the possible variations of e_B of the end-product molecules and of e_x of the atom groups forming product molecules of any interim energy state x, are subject to this energy control. It follows that in so far as the furnace-energy atmosphere exercises a thermal control over the magnitudes of the quota e_x of state x, these may not, for any appreciable part of the total energy involved, be forced to such low levels of internal atomic energy that the contributing release quota Δe_x can differ by no more than a fractional part of its mean value. The entire question then becomes one of determining the probability of the existence, for the state x, of potential chemical energy e_{C_x} that is large as compared to the net potential chemical energy e_C of the atom groups which finally appear in the end-product molecules.

But such a value of the potential chemical energy of the atom groups necessarily involves an interim reaction stage which cannot be fitted into the picture of the course of such a reaction in so far as it may be judged by what is known about it with reference to the product molecules which appear in the final state B. For if the potential chemical energy e_{C_x} is considerably larger than the potential chemical energy e_C, then a chemical constitution of atom groups for state x must exist which differs considerably from that for molecules in state B. Whatever is the interim chemical constitution of such product molecules in the known state B, they must all, except for a possible negligible portion of the total energy involved, finally attain, for this energy state, the chemical constitution corresponding to this state, and this will occur when the total released energy ΔE is equal to that which has been measured, for instance, in the calorimeter. The freedom as to chemical composition of state x is thus restricted with reference to the first law of thermodynamics by this condition.

Suppose for a moment that all of the atom groups involved react, in the interim, to form the hypothetical product molecule of state x. Each will then have released the hypothetical extra large exothermic quota Δe_x, whereas, when these molecules continue in the reaction and finally arrive at known end state B, the mean release quota Δe_B will be very much smaller than is the large interim hypothetical quota Δe_x. It will only be possible to obtain this result for the completion of the reaction following the hypothetical interim state x if the succeeding stages are substantially endothermic so that the net energy absorption in such stages is equal to the difference between the large exothermic quota Δe_x and the net quota Δe_B of the known state B. From this it may be concluded that the hypothetical interim state x is possible only if the energy quota e_x of the resultant molecule of state x is smaller than the energy quota e_B of the known end-state molecule by the amount by which the extra large exothermic quota Δe_x exceeds the net end-release quota Δe_B.

But if such conditions should be realized for all of the molecules of interim state x and in the meantime the total released energy between states T and x should have been discharged by radiation from the reacting system, then there would be no source from which to take the energy required for the subsequent endothermic reaction as it passed from state x to known state B. It follows that if such an interim reaction is possible at all, it may occur for only a part of the involved product molecules, and the greater the divergence of the large exothermic quota Δe_x from the mean quota Δe_B, the smaller will be the fraction of the total number of molecules which may undergo this hypothetical interim reaction. Thus not more than one-half of the large exothermic quota Δe_x could be more than twice as large as the smaller mean quota Δe_B, nor could more than one-third be more than three times the mean quota Δe_B, etc.

Since this is an attempt to discover not whether these quota are two or three times the mean quota but rather if any appreciable portion of the total energy involved may be released in quota several hundred times the mean quota, it follows that such special characteristics of the radiation, whose possible existence is the subject of this investigation, involve a hypothetical process in which the total effective combustion radiation must be emitted by probably less than one per cent of the total product molecules formed in the reaction. In such a process an appreciable group of the atoms, all of which are of the same several kinds, are considered as behaving macroscopically in one way, while those in another considerable group of the same several kinds are considered as behaving macroscopically in a distinctly different way when the macroscopic exposure to the energy atmosphere of the furnace is identical for both groups. That such a difference in behavior could exist under such conditions for appreciable parts of the energy involved is not consistent with the behavior of energy when considered on the basis of the second law of thermodynamics as set up to specify the probable distribution of energy.

Thus it is clear that the influence necessary to drive the hypothetically low interim energy state x into existence and hence result in the hypothetical interim molecule of state x cannot, for any appreciable part of the energy involved, have its origin in the control exercised on such atom groups by the energy atmosphere of the furnace. Whatever differences, of the order of magnitude under consideration, exist between the release quota Δe_x and Δe_B must have been caused by conditions to which the involved atoms and molecules were submitted prior to their injection into the furnace atmosphere. But just prior to injection into the furnace they existed in a state T, which we are justified in considering as a state of thermal equilibrium. For this state the energy distribution has been shown to be such that any possible variations of the mean energy intensity, for any appreciable part of the total involved energy of this state, are so small as to make it impossible to account for the release of a number of such extra large exothermic quota Δe_x sufficient to influence macroscopically the furnace atmosphere. Indeed, if this should not be the case and an appreciable portion of the energy of state x should, by virtue of the unusually large exothermic release quota Δe_x, be reduced to energy quota per product molecule of state x of unusually low thermal quota e_x, the characteristic radiation of such molecules would show up as peculiarly placed bands in the emission spectra. There is, of course, no evidence to this effect. However, the important point is not that such characteristic bands have not been observed but that it would be an utter waste of time to look for them in the atmosphere of the furnace in which the fuels considered are burned under the conditions considered. Thus it is apparent that no events in the reaction between the states T and B can be so peculiar as to change the conclusions already drawn concerning the significance of the magnitude of the release quota Δe as computed from the relation $\Delta e = \Delta E/N$.

Transformation of Release Quota Δe Into Quanta of Radiation

Finally, what is the probability that each quota Δe that is released may be emitted as a single quantum of energy H?

The emission of the released energy quota Δe as a single quantum of energy represents, macroscopically, the emission of lowest probability. In fact, unless there is a certain threshold loss of availability as the quantum emerges from the molecule, the process appears to be a strictly reversible one. But even if this

loss exists, emission of the energy quota Δe as a single quantum is still the least probable of the subdivisions by quanta which may occur.

It is an established fact that the quantum of energy is indivisible during the interim between its emission and absorption. During this period it is completely defined by the unchanging value of the product $h\nu$. Certainly, except for a threshold loss, there can be no increase of the entropy at absorption because the quanta are here absorbed in discrete units. Therefore, with respect to the energy-release quota Δe, the entropy will increase most when the several quanta emitted are of the lowest frequencies ν. This means that macroscopically there is much greater probability of emission of energy in small quanta than there is of its emergence as a single quantum whose energy is Δe.

If the threshold loss should be zero, the emission of a quota Δe as a single quantum is a strictly reversible process. To show this, consider two molecules, A and B, just alike, within a cavity whose walls are perfect reflectors. Molecule A exists at this instant as uncombined atoms which are just ready to combine with an energy release quota Δe. Molecule B has lost this amount of energy before being placed in the cavity, and, hence, has an energy content less than that of A by the amount Δe. The atoms of A combine and release Δe as a single quantum of radiation. Molecule B absorbs this quantum, is restored to its energy state A before combination, and must therefore break down into its group of atoms. Obviously, the process may now be reversed without any communication with outside systems and hence violates the second law of thermodynamics. If the energy Δe of A is emitted in a number of discrete units or quanta smaller than Δe, each in turn, at least at the beginning of the process, may be absorbed by B, building up its quantum state as that of A decreases. At a certain point in the reaction the quantum level of B has increased until it equals that of A which has decreased correspondingly, and after this instant further increase in the energy release Δe can result in a maximum difference in quantum level between the two molecules no greater than the equivalent of a single quantum, the last quantum just exchanged between the two. This process obviously involves an increase of the entropy of the system and will occur most frequently if it is at all possible. The fact that in such an equilibrium state it is still possible to consider the exchanges of energy by the last quanta as reversible is beside the point.

Two ways in which the process could occur, both of which have been considered on an identical and, in certain respects, ideal basis, have been compared. Macroscopically, the most probable direction of the process, if it may proceed in several ways, is that which is most nearly in accord with the second law of thermodynamics. It is therefore concluded that the energy quota Δe is not emitted as a single quantum of energy.

One other point merits a brief discussion. What are the prospects of delivering the energy to the absorbing surface in the form of large quanta, even though the discharge may have been in units of smaller quanta? The sum total of the energy delivered for absorption may, of course, not exceed that discharged by radiation, and, as Planck says, a molecule can not draw quanta of radiation into itself from without; it can absorb only those which strike it. Therefore the only way in which the energy may be delivered in units of larger quanta than those in which it is discharged is by building up larger quanta from smaller ones while in transit. For example, two low-frequency quanta might combine to build up in transit a single quantum of greater frequency. This amounts to an increase of the intensity of the energy in a self-acting process, and as it violates the second law of thermodynamics, it is inadmissible.

Thus, neither at the instant of emission nor at any time thereafter is it possible to generate for any appreciable portion of the energy involved in a combustion process, quanta having frequencies beyond the infra-red zone of the spectrum. This is the answer to the question which was put at the beginning of this paper. Radiations which emanate under these conditions, therefore, can have no special characteristics except, possibly, in the case of a fraction of the total energy so small that it is not measurable, even by the refined methods of the physicist.

A fairly complete picture of the general characteristics of the process is now available although certain details are still lacking. These will be discussed in connection with the development of the Planck radiation equation.

(To be continued)

Sources of Coal Used by Electric Public-Utility Power Plants

THE following tables are based on reports courteously furnished by the utility companies. The inquiry was sent to all plants on the Geological Survey's lists consuming as much as 2000 tons a year and to many still smaller. A considerable number of little plants were not canvassed, but as their combined consumption amounted to less than 2 per cent of the known total for all plants, the omission does not impair the representative character of the results.

Hand firing is still practiced at some small plants built years ago, but the total quantity burned under hand-fired boilers was only 973,000 tons or 2.3 per cent. Fully 97.7 per cent of the coal burned was fired mechanically, either on stokers or in pulverized form. Special interest attaches to the quantity consumed in powdered-coal burners, which was found to be 7,112,000 tons, or 17 per cent of the total.

TABLE 1 SUMMARY OF COAL CONSUMED BY ELECTRIC PUBLIC-UTILITY POWER PLANTS IN 1928, GROUPED BY TYPE OF COMBUSTION EQUIPMENT

	Net tons consumed	Per cent of total
Burned as pulverized coal	7,112,739	17.0
Burned on underfeed stokers	20,567,496	49.0
Burned on overfeed stokers	1,242,040	3.0
Burned on chain-grate stokers	12,057,883	28.7
Burned under hand-fired boilers	973,068	2.3
	41,953,226	100.0

Among the factors influencing the location of power plants is an adequate supply of condensing water. It was found that 60.3 per cent of the total tonnage of coal was consumed by plants located either on tidewater, on the Great Lakes, or on certain of the largest rivers. The greatest concentration, it appeared, lay at the Atlantic seaboard from Chesapeake Bay north to Boston.

TABLE 2 COAL CONSUMED IN 1928 BY ELECTRIC PUBLIC-UTILITY POWER PLANTS LOCATED AT TIDEWATER, ON THE GREAT LAKES, OR ON SIX LARGE RIVERS

Location	Net tons
Plants on Atlantic tidewater:	
Chesapeake Bay and north (including Washington, D. C.)	10,431,138
South of Chesapeake Bay	260,061
Plants on Gulf Coast	34,268
Plants on Pacific Coast	125,029
Plants on Great Lakes	7,785,982
Plants on Susquehanna River	556,624
Plants on Allegheny, Monongahela, and Ohio Rivers	3,343,115
Plants on Missouri River up to South Dakota line	1,044,358
Plants on Mississippi River up to Minneapolis	1,733,151
	25,313,726

Virtually every producing district supplied coal to the electric public utilities in 1928, but certain districts furnished the bulk of the supply.—From report of a study made by the U. S. Geological Survey in cooperation with the Institute of Economics of the Brookings Institution.

How Safe Is a Factor of Safety?

By J. DILOT,[1] MILWAUKEE, WIS.

BACK in our minds most of us feel that the factor of safety of a pressure vessel is an arbitrary addition to the supposed strength of the vessel which takes care of a suspected but unknown weakness some place. Officially it is the added margin of strength to protect the user. We should like to think of it as representing the actual safety over and above the known strength of the vessel, added to take care of possible abuse in operation, the effects of age and contents on the material, and other weakening agencies beyond the control of designer and builder.

A usual factor of safety is 5, which should be ample if it were true. It is, however, an admission that the design is not all that could be desired and the safety uncertain. It is really a factor of ignorance.

Assume that a vessel is tested to destruction and it is found that the factor of safety instead of being 5 is only $2\frac{1}{2}$. Would it not be sufficient then to figure with $2\frac{1}{2}$ in all cases where the true strength—and there are ways of finding out the true strength of most vessels—is known?

The danger of being like the ostrich and hiding for safety is brought home more and more strongly as the technique of utilizing higher temperatures and pressures advances. The dangerous factor of ignorance is gradually becoming an ever-increasing part of the so-called factor of safety. Only by a proper understanding of this situation can the user be protected from unnecessary risks.

Knowing the situation and having the user's safety at heart, how can this old by-word "factor of safety" be made to come up to specifications? The factor of safety is determined by means of the formula $PD/2T$. It is based on the stress in the cylindrical plate, and this stress is the easiest to calculate. Incidentally the cylindrical plate is considered as being the most lightly stressed part, more for convenience than because of the facts. So, having found the maximum stress and on the supposition that the ultimate strength of the material is known, the relation between them becomes the factor of safety.

Against these methods of dealing with pressure-vessel design even though they are sanctioned by all codes and regulations, several objections can be raised. First, no apparent attempt is made to arrive at a design of uniform strength; second, with this fact known, the safety factor is not based on the weakest point as it should be; third, the ultimate strength is a vague value which seldom is based on operating conditions and long-time tests.

Opinions vary, and this is just one of them, but some simple tests will be convincing. For example, put lime wash on various suspicious spots of a vessel, like points of discontinuities, and raise the pressure slowly. The lime will crack off in places where the metal, yields first, and stress lines will develop showing where the strain is obviously greater than elsewhere.

[1] A. O. Smith Corporation. Mr. Dilot received an M.E. degree at Chalmers University, Gothenburg, Sweden. He joined the engineering staff of his present firm in 1919, where he was engaged in designing special and automatic machinery until 1925, later assisting in the reorganization of the plant. Since 1925 he has been assistant manager of publicity and sales development.

Another way is to use strain gages on points where there is reason to suspect intensification of stress. Thus it is possible to calculate the actual stress at each particular point. A comparison with the theoretical girth stress sometimes is startling, and we begin to realize the fallacy of depending on a theoretical factor of safety.

However, if we really want to get to the bottom of the thing, the surest method is the testing to destruction of the full-sized vessel. That will tell how close to being uniformly strong a certain design is. It also will give us the true factor of safety provided proper care is exercised in determining the ultimate strength of the material at the operating conditions.

It must be granted, then, that means exist of finding out the weakness of vessel designs, and if we have the user's safety at heart, we should find them out. Our goal is, of course, the 100 per cent vessel, meaning one which is as strong in any part as in every part. Such vessels can be and are being built, and have been tested to destruction, bursting all over simultaneously and at a pressure equivalent to the ultimate strength of the steel.

But the 100 per cent vessel can be produced only by eliminating three common weaknesses: First, dished heads (any engineer knows that they are only 60 per cent as strong as the elliptical head, which equals the cylinder in strength); second, the unreinforced openings, which weaken the vessel down to 40 per cent of that of the shell proper; and third, joints and seams having lower strength than the plate itself. As long as these remain, all other efforts toward a 100 per cent vessel are wasted. One-hundred per cent joints do exist and can be obtained without thickening the joint area. It should be remembered that abrupt increase in wall thickness is only apt to create new points of stress intensification.

Assuming that it has been possible to build a 100 per cent vessel, there is still one more pitfall before the true factor of safety is arrived at. As already indicated, the ultimate strength on which to base it must be known. Take, for example, a vessel of 5 ft. inside diameter with a wall $1\frac{1}{2}$ in. thick, built of ordinary 50,000-lb. steel and operating at 500 lb. and 900 deg. fahr. It might be thought that, with an operating stress of $\frac{60 \times 500}{2 \times 1.5} =$ 10,000 lb., the factor of safety would be the desired 5. However, at 900 deg. fahr. steel fails at a stress of 30,000 lb., so the safety factor would really be only 3 But the stress of 30,000 lb. is based on short-time tests, and recent discoveries from long-time tests show that the ultimate strength is only 18,000 instead of 30,000. The real factor of safety is now down to 1.8, but if this were not known there would be no occasion for worry, because there is, of course, no immediate danger of failure. On the other hand, if dished heads (60 per cent heads) had been used or some other weakness had been present, a disaster would have resulted.

Designing pressure vessels is indeed a great responsibility, and building them is one of no lesser degree, but the manufacturer's attention should not end here. In addition to constant vigilance to maintain a 100 per cent job and the testing to destruction of new types before they are marketed, the manufacturer should thoroughly test every specimen of his product before it leaves his plant. He should not be satisfied with barely ascertaining that each vessel does not leak excessively at 50 per cent over working pressure, but he should make the test severe enough to demonstrate that his claims for correct design and workmanship are

well founded. Only by such a severe test can the purchaser feel satisfied that the potential disaster he is putting into his plant is safely harnessed. No theoretical factor of safety, be it ever so high, can give the same feeling of security unless actual demonstration proves its correctness.

It is conceivable that the number of accidental failures in service could be further reduced by carrying vigilance still farther. Many pressure vessels are subjected to corrosive or embrittling action, or deteriorate in other ways at an unusual rate. They should be subjected to a thorough test periodically to insure their safety, not merely examined. It would even be desirable to take individual vessels out of service and test them to destruction, thus gaining valuable knowledge and data to guide in the design and operation of future units for similar service.

Existing codes and regulations governing the manufacture and operation of pressure vessels date back some time in most cases, and cannot therefore be expected to follow the line of thought expressed above. No doubt they will continue to progress and in time recognize established engineering principles of today, but in the meantime manufacturers should strive to go the codes one better by dropping the obsolete and adopting the new and proved.

The foregoing discussion does not pertain to any one particular manufacturing process. Pressure vessels can be produced by widely different means, but some are suffering from greater disadvantages than others, and are therefore destined to be discarded. However, engineering is rapidly progressing, and it seems that we are now on the threshold of an era when uniformly strong pressure vessels can be commercially produced, and when there will be no mystery attached to that significant expression, "factor of safety."

Recent Progress in Aviation[1]

IN 1927 we did not have, from a commercial standpoint, an aircraft industry, therefore we had no perfected method of production, no sales policies, no knowledge as to what our market for airplanes would be.

During the last three years, however, feverish progress has been made. Airports have sprung up all over the country, so that today we have 1650. There are 15,000 miles of fully equipped airways, including intermediate landing fields, beacon lights, radio, telegraph and weather service. There are 13,867 licensed pilots. Airmail lines have been extended to all the important centers and passenger travel by air is becoming a commonplace. There are regular airlines having scheduled flights for passenger flying and mail of 100,000 miles per day, or 30,000,000 miles per annum. In 1929 these regular airlines actually carried 150,000 passengers and 8,000,000 lb. of mail. In 1929 miscellaneous flying, including not only the scheduled flights mentioned above but individual flights, etc., amounted to 125,000,000 miles.

One of the great companies a little over two years ago proposed to build a Diesel aircraft engine. At that time the popular-sized engine was a 225-hp. All of the 5-place airplanes were using them, and it was the size which gave the Wright Aircraft Corporation its first great success in the engine field. It required, however, two years to bring out this engine, and it was then no longer the most popular size. The manufacturer will probably have another size ready next spring.

Recently, there has been developed a device called the "Mecaaviator," which is a robot control of the plane, and which flew a airplane from Dayton to Washington recently with perfect success. These robot controls operate much more smoothly than the manual controls and, I believe, will ultimately be used widely by transportation companies.

The Detroit Aircraft Corporation, working in conjunction with the Russell Parachute Company, has developed a parachute which is large enough to lower an airplane with its cargo and land it no faster than a man would land with the ordinary standard army parachute. With this plane parachute there is used a pilot chute, 12 ft. in diameter, which pulls out the larger plane chute. It was found during experiments that a plane in a tail spin, or any uncontrolled maneuver, would instantly be brought to a level keel by the 12-ft. pilot parachute. This, in itself, is a great step toward safety.

Today transportation by air is a business and it must be based on business principles. There are two classes of planes available for use on airlines, one the very speedy small plane, carrying from five to ten passengers, with a single engine, beautifully streamlined, which can operate at about 5 cents per passenger-mile, and the other is a very large plane, carrying 30 to 40 passengers, which, if carrying a full load, can operate nearly as cheaply.

In order to get full loads, the passengers should be carried in vibrationless, noiseless planes, and the engineers today are working toward this end. The Bureau of Standards has developed an insulator for cabin planes, the basis of which is "dry zero," a kapok fiber, very fluffy and resilient in nature, which has produced surprising results. For airplane work it comes in blanket form bound up with cheesecloth. The 2-in. thickness weighs about 0.2 lb. per sq. ft.

Experiments are being carried on by a certain firm in Michigan whereby they take the exhaust gases from the engine, carry them through a hollow propeller and expel them from the following edge of the propeller. This brings double results: it absolutely silences the motor, scavenging it at the same time, and fills up the vacuum formed by the blades which is the cause of propeller noise. These experiments have yet to overcome the problem of heat in the propeller. When this is done, airplanes may be more silent than automobiles.

To date 597 people have crossed the North Atlantic non-stop via air. Of these, 564, or about 95 per cent, have flown via dirigible. All eleven attempts to fly the North Atlantic via rigid airship have been successful, no lives have been lost, and considerable pay load has been transported.

These facts seem to justify the conclusion that the commercial conquest of the ocean via air is the function of the dirigible rather than of the airplane. The commercial value of the airship of transoceanic size, say, 300 tons, is demonstrated in startling fashion when compared to the performance of the U.S.S. *Leviathan*. Engaged in transatlantic service, the *Leviathan* fully loaded carries only 4 per cent of its gross displacement in pay load, at a speed of 24 knots, whereas the 300-ton airship, in addition to its crew and a 50 per cent fuel reserve, will be able to transport 21 per cent of its gross displacement in pay load, at a speed ranging from 70 to 80 knots.

Careful study comparing present modes of transportation with air transportation shows so conclusively the economy of the latter, that I can say without hesitation that it is the future means of transportation for the world.

[1] Edward S. Evans, President Detroit Aircraft Corporation, in an address at the National Aeronautical Meeting, Chicago, August 25, 1930.

Survey of Engineering Progress

A Review of Attainment in Mechanical Engineering and Related Fields

AERONAUTICAL ENGINEERING

Motorless Flight

THE author has for a number of years carried out experiments to determine why birds can fly with apparently little effort. In the course of these experiments he placed various stuffed birds in wind tunnels and incidentally found that as an airfoil the bird is not greatly more efficient than an airplane. He therefore came to the conclusion that the efficiency of bird flight is due to the bird's ability to utilize up and down air currents, and he believes that the bird does this by making use of the common senses of hearing and sight rather than by any special physiological methods not available, for example, to humans. He pays particular attention to the matter of hearing. Thus in 1922 he obtained interesting results by placing a microphone within a wing so that the upper surface of the wing was formed by the receiver membrane of the instrument. When this wing was placed under various conditions in a current of air from a blower, certain interesting observations were made. When the wing was inclined forward there was clearly distinguishable in the microphone which was directly struck by the air the characteristic elements of the turbulence of the blast produced by the fan. The intensity of this phenomenon decreased as the wing was raised, and became very feeble for incidence corresponding to flight. Beyond that, however, an increase in incidence caused a new noise of a different character.

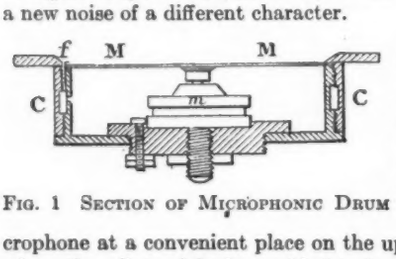


FIG. 1 SECTION OF MICROPHONIC DRUM

In a communication published in 1923 in the Proceedings of the French Academy of Sciences (*Comptes Rendus*, March 26, 1923), the author suggested that by locating a microphone at a convenient place on the upper surface of a plane wing, the pilot might be enabled to know whether he was in a column of ascending or descending air flow. If two microphones were located symmetrically to the median plane of the airplane, the pilot could be instantly apprised as to the direction of the wind striking his airplane. This arrangement is really equivalent to transferring the ears of the pilot to the place on the wing most sensitive to the reception of sound. For this purpose the author designed "microphonic drums" (Fig. 1), consisting of a mica diaphragm about 50 mm. (2 in.) in diameter, held in a brass cup *C*. Between this mica diaphragm and the bottom of the cup is located a carbon-grain microphone *m* of the solid-back type, transmitting the vibrations of the diaphragm to the telephone receivers on the pilot's head.

The cavity in which the microphone is located is in communication with the air by means of a very narrow short passage *f* which opens on the upper edge of the cup in such a manner as to permit the air to have the same average pressure on both sides of the mica diaphragm, which is then affected only by the rapid changes of external pressure. The author shows the details of installation of this apparatus, which, however, cannot be described here because of lack of space.

In 1924 and 1925 some tests were made on a Hanriot plane volplaning with the motor stopped at heights of 1000 to 2000 m. (3281 to 6562 ft.). The drums, located at a distance of 2.25 m. (7.38 ft.) on either side of the plane of symmetry, were placed first at a distance of 44 cm. (17.3 in.) and then at 28 cm. (11.0 in.) from the front edge of the plane. In this latter position a clear change of timbre of sound was distinguished when the plane was zooming or diving.

It has not been found possible to carry these experiments to a final conclusion, but it has been established fairly clearly that the expectation that this apparatus will indicate changes in wind striking the plane is justified.

To check his ideas the author suggests that certain birds, for example, vultures, be captured and their ear drums closed up, whereupon their flying ability could be observed. (Col. A. Lafay, Professor at the École Polytechnique, in *Le Génie Civil*, vol. 96, no. 25, June 21, 1930, pp. 606–607, *e*)

Six Years' Progress in Water-Cooled Aero Engines

AN IMPORTANT fact in favor of water-cooled engines is the better control of cylinder temperatures, enabling them to carry safely the load, a matter of particular importance in multi-cylinder engines.

As regards first cost, it is more difficult to compare water-cooled and air-cooled engines than is apparent at first. The former, as regards running costs, has the advantage for both fuel and oil consumption. In regard to cost of overhaul, it is generally assumed that the air-cooled engine has an advantage, but even that is becoming less important. As regards development, there is evidence to show that it will be in the direction of relative reduction of cylinder capacity on a given crank, with high mean effective pressures and rate of crankshaft revolutions.

If we look at the figures for engines that have passed the British Air Ministry's type test, we shall find that a naturally aspirated engine at its rated power has a b.m.e.p. of 133 lb., and that what is called a moderate supercharger engine, which has a small degree of ground boost, has a b.m.e.p. of 143 at its rated ground b.hp. The latter is a gated engine and compares in use with a high-compression engine protected by a gate against overload on the ground. The weight of these engines per b.hp. at ground level is 1.76 lb. and 1.71 lb. per b.hp., respectively, or 1.6 and 1.56 at maximum power. It should be noted that these are geared engines, complete with all accessories. While one may consider these figures quite good, the advent of the supercharger has given an engine with a b.m.e.p. of 130 lb. at 11,500 ft. altitude for a weight per b.hp. at that altitude of 1.88 lb. compared with a figure of 90 b.m.e.p. and 2.62 lb. per b.hp. for a normal engine under the same conditions. If we examine the b.hp. on a capacity basis, the normal engine shows a figure of 37.8 b.hp. per 100 cu. in. and the moderate supercharger 40.5. These figures are at the normal rated b.hp. At its maximum power the Schneider Trophy engine has a figure of nearly 90 b.hp. per 100 cu. in.

There is an increase in the variety of engines of different powers now available, particularly in the air-cooled class in the smaller sizes, and in the water-cooled type for the larger ones. The author is of the opinion that at present the 500-b.hp. engine is

one of the most useful sizes for transport work, but larger sizes seem necessary, and the 1000-b.hp. unit may soon be in demand; the 800-b.hp. is already available.

The next six years should see the general adoption of evaporative cooling, or, as it is generally termed, steam cooling, with or without the general adoption of the use of a fluid other than pure water as the cooling medium. Enough experimental work has already been done to make the success of such a system quite certain, giving us at once completely automatic cylinder-temperature regulation and a lighter cooling system without drag. This system is the answer to the reduction in resistance obtained recently on air-cooled engines by improved cowling. But the author feels that air cooling can never be controllable, and that an engine must always be rather overcooled if any margin of safety is to be attempted.

Evaporative cooling has been applied already on the airship *R-101*, and gives an automatic temperature regulation together with a lower combustion-wall-space temperature.

The author considers as the most important development of recent years which is coming to the fore in connection with military machines, is the application of the geared centrifugal blower to supercharge the engine cylinders. The rotors of these blowers are run up to 32,500 r.p.m., and on the 11,500-ft. supercharged engines the speed is 27,000 at the maximum permissible speed of the engine.

In the original article is shown a section of the F-type Rolls-Royce engine, which includes a slipping device on the layshaft drives and a flexible drive through a slender shaft, the torsional deflection of which is limited to a reasonable amount by stops.

A simple device developed by Rolls-Royce takes the form of an expanding air intake—it is really another form of supercharger. Advantage is taken of the fact that the speed of the airplane is usually more than the air velocity in the usual type of intake. The mouth of the intake is arranged to take in a slice of air without spilling, and the velocity is reduced in the expanding pipe to be converted into pressure energy. This type of intake is applicable to any engine in any machine of sufficient speed. We can refer to a supercharged engine with such an intake as having three-stage compression, though, unfortunately, we still have only single-stage expansion. The reduction in resistance in an intake of this type is considerable owing to its reduced size and small eddy effects if suitably placed. In fact, it is the cheapest and also the lightest means of increasing the power of an engine yet found. The efficiency is also very high, and very little heating of the air occurs during this preliminary compression. The air-flow conditions are more constant, and less trouble is found in maintaining uniform balance conditions in the carburetor.

The British Air Ministry now allows a certain amount of detonation with standard fuel if the engine can stand up to a 20-hr. run in addition to the standard type test, with the engine speed pulled down to ground running conditions and developing full power at that speed. As the same engine is used for all the runs, the severity of the type test is increased, but the author agrees that this is a move in the right direction.

After complete reliability has been achieved, engines will have to become more silent in operation, in themselves, their exhausts, and be fitted with silent airscrews. Perhaps this is the point of which we can make least claim to have progressed in the last six years, the best result to date probably being obtained in the old six-cylinder-in-line water-cooled engine, with a direct-drive airscrew and long exhaust pipe. While the author does not regard this matter as being as important as, say, reliability and sufficient performance to enable machines to be run at a profit, at the same time silent running is much to be desired for our greater comfort. It may be that military requirements will supply the impulse to get engineers working at this problem of the silent airplane. It is certainly needed for passenger aircraft. (A. J. Rowledge in *Journal of the Royal Aeronautical Society*, vol. 34, no. 235, July, 1930; original paper pp. 578–590, 9 figs., and discussion (not abstracted), pp. 590–602, *cA*)

AUTOMOBILE ENGINEERING (See Internal-Combustion Engineering: The Junkers Aircraft Engine)

FUELS AND FIRING

Fuel Problems at American Chemical Society Meeting

MANY interesting papers on coal and gas fuels were presented by the Division on Gas and Fuel Chemistry at the Annual Meeting of the American Chemical Society, held in Atlanta, Ga., April 7–11, 1930.

S. P. Burke and T. E. W. Schumann presented a physical theory to explain the mechanism of the combustion of pulverized fuel. The theory proposed was that each particle of fuel on moving through the combustion chamber was surrounded by a film of gas through which the oxygen of the furnace atmosphere must reach the solid fuel particle by diffusion. They further stated that the thickness of the film was a function of the size of the particle, the temperature of the furnace, the temperature of the particle, the relative velocity of the particle through the furnace atmosphere, and similar factors. It was found possible to evaluate the thickness of these films and thus to compute the rate of reaction between the fuel particle and the surrounding air.

In cooperation with the American Gas Association, the U. S. Bureau of Mines has undertaken a survey of the gas, coke, and by-product-making properties of American coals, and, according to A. C. Fieldner and J. D. Davis, the investigation is designed to cover the entire temperature range at which coal may be carbonized, beginning at 500 deg. cent. and ending at 1100 deg. cent. The yield and quality of products are plotted against carbonization temperature, thus giving a chart which indicates the optimum carbonization temperature for a given coal. Results obtained on a Pittsburgh-bed coal taken from the same mine from which coal was furnished for full-scale carbonization tests by the American Gas Association in commercial retorts and ovens, showed that the yields obtained in the Bureau of Mines test apparatus compared favorably with those obtained on full-scale tests.

W. F. Hamilton described an apparatus for the continuous indicating and recording of the percentages of carbon dioxide and oxygen in air. The method is based upon measurement of the relative thermal conductivity of gases, using quartz-protected platinum spirals as heating and temperature-measuring elements. He described an improved thermal-conductivity gas-analysis unit, and showed the effect of varying gas composition, temperature, current, and flow rate. Successful operation of the apparatus was shown to depend largely on the maintenance of a Wheatstone-bridge circuit which was only slightly unbalanced, and the adjustment of the cells to a point where the rates of heat dissipations from the reference and analysis spirals were very nearly identical. (*Fuels and Furnaces*, vol. 8, no. 5, May, 1930, pp. 643–645, *g*)

Grinding Tests With a Simple Tube Mill

THIS investigation was undertaken by a joint committee of the Government and the German Portland Cement Manufacturers' Association to elucidate the laws of grinding coal for a simple tube mill, and thus obtain a basis for projected investigations on tube mills with air separation. The mill used for the tests was a Polysius 3-compartment mill, 38 ft. long and 4 ft. 8 in. in diameter. The first two compartments were charged

with steel balls and the third with flints, the total weight being 5.1 tons. The power consumption running empty was 92 kw., the speed of rotation being 27 r.p.m. A fairly hard Ruhr coal of inferior quality was used.

Throughout the tests the quality, moisture content, and grading of the coal were as far as possible maintained constant; the feed contained 9 per cent above 7 mm. diameter and 10 per cent below 0.25 mm. The rate of feed was varied, and the effect on fineness and power consumption studied. Size rates of feed were investigated, one of which may be ignored since the mill was overloaded. The tests (each of which lasted 2 to 4 hr). began and ended with the mill fully charged. The output was analyzed on sieves having approximately 250, 200, 180, 125, 100, and 80 meshes per linear inch, but the residue on the 180 sieve gave a fair representation of the fineness of the product.

In the five tests the output varied between 0.87 and 3.02 tons per hr., and the residue on the 180 sieve between 3.3 per cent and 18.5 per cent. The results showed that grinding to less than 15 per cent residue on the 180 sieve does not appreciably reduce the residues on the 80 and 100 sieves (some 2 per cent), and is thus of no practical value; on the other hand, the proportion of fine metal is greatly increased by grinding to less than 15 per cent on the 180 sieve, which requires increased work per unit of output.

As the output is reduced the fineness increases (i.e., the sieve residues are diminished), though not proportionately; equal steps in output reduction correspond to smaller steps in fineness as the fineness increases. Overall power consumption remains practically unchanged whether the mill is running empty or grinding coal; it is even possible that slightly less power may be consumed in the latter case. Thus the work done per unit output varies inversely as the output. It follows that variations in the hardness of the coal will not affect the power consumption, but will show in the different fineness of the product at a given point.

The tests showed also that the moisture content of the coal is an important factor in tube milling; reducing the moisture content from 3.6 per cent to 0.5 per cent enables the output to be almost doubled (i.e., 3 to 5.2 tons per hr.), while maintaining the same fineness in the product.

To increase the fineness from 15 per cent to 5 per cent residue on the 180 sieve the output must be reduced in the ratio 100:55.5, and the work per unit output increased in the inverse ratio. The investigation indicates that, for the mill and coal used, the best results are given by grinding to 15 per cent on the 180 sieve, which requires 34 kw-hr. per ton. (Grosse, Forderreuther, and Rammler in *Zement*, vol. 19, no. 9, Feb., 1930, pp. 189 and 214; abstracted through *Cement and Cement Manufacture*, vol. 3, no. 6, June, 1930, p. 838, *e*)

HYDRAULIC ENGINEERING

Hydraulic Characteristics of Flow of Water Around Bends

COOPERATIVE researches on the flow of water around bends have been carried out by the U. S. Bureau of Public Works and the University of Iowa, under the direction of S. H. McCrory, Chief, Division of Agricultural Engineering, Bureau of Public Works, and Professors S. M. Woodward and F. A. Nagler of the University as consulting engineers. It has been found that where the friction along the bottom of the channel is greater than that along the top, with this velocity distribution in the channel approaching the bend, the water will take a single spiral or helical motion in addition to its forward motion in flowing around the bend. Such spiral motion exists at the bends of rivers and is the cause of erosion along the outer bank. The water with highest velocity is, however, not along the outer bank as commonly supposed, but is along the inner bank, and it is believed that the erosion at bridge-pier noses is due to a similar action.

The question may well be raised as to the practical importance of this spiral motion of water in bends. Since this motion represents head lost, attempts to straighten out the direction of flow of the filaments of water should result in increased efficiency. Quarter-turn draft tubes are now designed with guide vanes in the bend so as to make the water flow in a straight direction as well as to reduce eddy losses. We also find that the General Electric Co. has used in the 90,000-kw. turbine at the Crawford Ave. station of the Commonwealth Edison Co., in Chicago, sharp 90-deg. bends equipped with blade turns designed especially to reduce the spiral motion and consequent eddy losses. Sharp 90-deg. bends equipped with blade turns have also been applied to blower systems. E. D. Edwards, chief engineer of the East Peoria Station of the Illinois Electric Power Co., has reported a saving equivalent to 347 tons of coal annually through the adoption of this type of bend in the duct system of his power plant. It is obvious that for water pipes this type of bend is practical only in the larger sizes. (Paper by D. L. Yarnell, Senior Drainage Engineer, U. S. Bureau of Public Roads, presented to the Iowa Engineering Society; abstracted through *Engineering News-Record*, vol. 105, no. 10, Sept. 4, 1930, pp. 376–377, 5 figs., *e*)

INTERNAL-COMBUSTION ENGINEERING (See also Aeronautical Engineering: Six Years' Progress in Water-Cooled Aero Engines)

A New Type of Two-Stroke Engine

AFTER reviewing various types of two-stroke-cycle engines the author expresses the opinion that the idea that a two-stroke engine must be completely scavenged with air has led to a line of development which, though logical enough, is not completely desirable. In the opinion of the author, if the proportion of residuals by weight is kept down to about one-fifth or one-sixth of the cylinder contents, as nearly an ideal state of affairs as possible will be reached. This may be done in four ways: namely, a partial exhaust stroke, a partial mixture scavenge, a partial air scavenge, and supercharging, and in practice can be attained either by a partial air scavenge or a combination of the two other methods. As this form of scavenge arrangement makes it desirable to prolong the exhaust stroke, the timing becomes asymmetrical, which, together with the necessity of super-atmospheric transfer, forces the use of some kind of valve other than the piston. The author shows a diagrammatic sketch of an engine where all of these requirements are satisfied. In another drawing (Fig. 5 in the original article) he has endeavored to obtain a cycle of operations approaching the requirements which he established. He uses a two-diameter piston working within a two-diameter sleeve, which is given a short reciprocating travel by an eccentric on the crankshaft set a predetermined angle behind the main crankpin.

Induction takes place in the annular space between the skirts of the piston and sleeve by the piston uncovering the sleeve ports, which are then registering with the cylinder ports. When induction is complete the sleeve closes the inlet ports and compression commences in the annular space.

When the pressure in this compressor has risen to about 15 to 20 lb. per sq. in above atmosphere, the transfer ports in the sleeve, which are then in register with the cylinder transfer passages, are uncovered by the piston flutes and transfer takes place under pressure, the exhaust ports closing at this point.

The transfer ports are closed by the sleeve when the "pumping rates" of the compressor and main piston become equal. The

angle at which this occurs is dependent on the relative diameters of piston and skirt, the strokes of piston and sleeve, and the angle of lag of the sleeve eccentric, and these factors were so chosen that the transfer ports could be closed not later than 15 to 20 deg. before top dead center.

It was hoped that the transfer blasts, meeting at very high speed at the sparking-plug points, would both clean and cool this vital point, and these expectations were completely fulfilled, a standard touring plug being used throughout the test without any sign of coiling up or of burning.

As regards the port areas, conventional gas speeds are not a criterion for the design in this case, and the author uses as his only guide the time-area integral.

The most striking features of the engine were its slow running and general good behavior, the exhaust note at 500 r.p.m., running light, being as steady and regular as that of the four-stroke and similar in tone. Carburation was quite uncritical, and a standard Zenith carburetor gave excellent results throughout the range of speeds and loads, though no effort was made to adjust it for economy.

The most serious trouble experiences was with magnetos, the type fitted being apparently incapable of withstanding more than 3500 r.p.m. for long. An aluminum cylinder was tried, but proved to be unsuitable on account of the high expansion properties.

The original article reports extensive data on tests of this engine, which seem to have been quite satisfactory as work has been started on a four-cylinder automobile engine. (J. W. Robertson in a paper before the Institution of Automobile Engineers, London; abstracted through *The Automobile Engineer*, vol. 20, no. 269, July, 1930, pp. 267–272, 18 figs., *d*)

The Junkers Aircraft Engine

THIS is the latest Junkers aircraft engine, developing 650 b.hp. at 1500 r.p.m., with a total weight without oil or water of 1860 lb., equivalent to 2.85 lb. per b.hp. At this speed the fuel consumption is 0.365 to 0.375 lb per b.hp.

The engine works on the opposed-piston principle. The fuel is injected through four open nozzles within a period of only $^1/_{1000}$ of a second. The engine is constructed as a two-crankshaft motor, one shaft at the top and one at the bottom. The power is transmitted from the crankshafts to a common shaft by gearing. The cylinders are of an aluminum alloy known as silumin. There are two fuel pumps for each cylinder, actuated from two camshafts in their turn driven by the center wheels on the main gearing. The governing and regulation of the fuel are effected by means of spill valves. (*The British Motorship*, vol. 11, no. 122, May, 1930, p. 79, 3 figs., *d*)

MACHINE-SHOP PRACTICE (See Special Processes: Removal of Oil and Grease From Metal Parts)

MEASURING APPARATUS

A Torque Meter for Measurement of Power Output of Aircraft Engines in Flight

THIS device was primarily developed to work with the gear reduction employed in the epicyclically geared Liberty engines and is illustrated in the original article. The apparatus was installed on a plane and a test in flight gave a large amount of data for various conditions and at various altitudes from sea level up to 20,000 ft. The original article gives values of full-throttle horsepower actually delivered to the propeller at various speeds of revolution at altitudes of 0, 2025, 5500, and 15,380 ft. With but very few exceptions the observed values fall on smooth curves. A curve in the original article represents the power obtained at different altitudes in the terms of the power obtainable at sea level with the same engine speed. The values lie exactly on a smooth curve. It is intended next to conduct similar tests on an airplane powered by an engine equipped with a supercharger for high-altitude duty, using an upright water-cooled Liberty engine. (D. Adam Dickey, Chief of the Propeller Unit, Matériel Div., Wright Field, Dayton, Ohio, in *The Journal of the Maryland Academy of Sciences*, vol. 1, no. 3, July, 1930, pp. 172–182, 7 figs., *d*)

PETROLEUM ENGINEERING

Methods of Securing Cool Water

THE petroleum industry needs large amounts of cool water both for cooling mechanical equipment and process cooling. The general methods used do not differ from those used in power plants, but some new equipment has been developed in the industry. The following may be mentioned:

The defects in chimney-type cooling towers led to the development of forced-draft towers where the forced draft is applied at the bottom of the tower to replace the natural draft of the chimney tower and in this way increase the efficiency of operation as well as control the air column. This type of tower introduces an item of expense for power to operate the fans, which require from 20 to 40 hp. per 100 gal. of water circulated per minute. There is also a relatively high loss of water by windage from the high velocity of air passed through the tower against the falling stream of water. This produces a mist which can be found objectionable in congested districts, but in the petroleum industry this type of cooling tower has been extensively used.

The louvre type of cooling tower gives a high efficiency and permits determining quite accurately its performance for given conditions. Cooling-tower guarantees in general are established upon final water temperature rather than on a guarantee of capacity based upon a certain number of degrees of cooling with given atmospheric temperature and humidity. The latter type of guarantee can rarely be verified as coincidence of stated temperature and humidity is accidental and may not occur for a number of years, thus virtually depriving the purchaser of legal relief.

A combination of the atmospheric-type cooling tower with spray nozzles used in the upper sections is now coming into use, the spray nozzles reducing the total height of tower quite materially. The spray nozzles are enclosed in a space surrounded by a wooden partition to reduce spray draft to a minimum.

By this system the advantages of cooling by evaporation of the water from the spray are added to the cooling by flow through the tower, and it seems to give promise of a wider use in future installations.

In either the straight louvre-type tower or the combination of spray and tower it is customary to install coils of $^3/_4$-in. brass pipe near the bottom of the louvre sections for the cool water to flow over. The material to be cooled is passed through these pipes.

To reduce loss of water by windage to a minimum the space between louvres is fitted with wind deflectors. These deflectors vary in design over a wide range, but all work on one principle—that of offering a tortuous outlet for the wind as it is leaving the tower. One type of tower is now being built with the wind deflectors playing a more important part in the design than the louvres.

In the standing-type atmospheric cooling tower the wind is directed downward under distributers from which the water is dripping and then upward again to escape. With high wind

broadside to the tower the water in circulation is lost very quickly, and it is therefore necessary to use the wind deflectors, which are made both manual and automatic in adjustment.

In working out details for a water-cooling system the plant engineer usually determines the best location possible, taking into consideration pumping conditions, water source, pipe work, exposure, property value, location of other buildings and equipment that might be deteriorated by spray blown from tower, and future expansions.

The next consideration is quantity of water to be circulated, maximum and minimum, and the temperature ranges to be covered.

As atmospheric conditions play a very important part in the operation of atmospheric-type cooling towers, a careful study of data available from the United States Weather Bureau will aid materially in determining details of the water-cooling system.

With these conditions in mind and also considering the possibilities of reclaiming the tower at some future date and moving it to some other locality, some operating companies follow very close to standard specifications, believing that the sacrifice of a small amount of efficiency is justified if the plants can be made interchangeable and can therefore be moved from one location to another as conditions demand. (I. G. E. Bignell in *Oil and Gas Journal*, vol. 29, no. 13, Aug. 14, 1930, pp. 41, 148, and 149, illustrated, *d*)

A New Mud-Separator Method

THIS method was recently used in bringing in the big town-lot well at Oklahoma City. It is claimed that it eliminates spraying the countryside with oil and mud, and greatly reduces the fire hazard. The well consists of the following:

Over the casinghead and above the control gates is placed a 3×15-ft. separator shell or mud hog. It is flanged on the top of the casing. A 4-ft. nipple protrudes above this flange on the inside of the shell. Around the wall of the mud hog, several feet above the upper end of the nipple, a plate, $1^1/_{16}$ in. thick, is welded. This is the wearing plate and it takes most of the shock of the rushing fluid as it expands after leaving the top of the nipple.

Some operators prefer to start the bailing of mud before installing the mud hog. In such cases the top of the shell is a solid piece of $1^1/_4$ in. thickness. If the bailing is to be done after the mud hog is hooked up, a 10-in. opening is made in the top. Through this hole a bailing nipple is run to the top of the short flow nipple and is only removed when the well begins to flow. The top opening is then closed with a bull plug.

The mud-hog shell is of 800-lb. test and has a 500-lb. working pressure. It was first thought that a heavier separator would be needed because of the 2200-lb. rock pressure. A striking discovery was made on the first well, however, when it was found that the pressure inside the shell seldom exceeded 40 lb. This was due to the large expansion chamber above the casing and to the 12-in. outside line.

This line leads to a special separator which is called a mud trap. While the well is being allowed to clean itself, all of the fluid goes directly to this trap, the flow gates to the regular separators being closed. The heavy-fluid float, shown on the side of the trap in the drawing in the original article, rises to tip a pilot valve as the fluid enters. Gas pressure through this valve causes the quick opening of a butterfly valve in the 10-in. discharge line. The fluid then flows through the line to the sump.

The primary purpose of these valves is to prevent the escape of gas through the discharge line. They are safety devices which eliminate danger of drifting gas at ground level. So long as the heavy-fluid level is sufficiently high for the float to function, the gas must go out through the upper lines to the larger separators.

Further details about this process are given in the original article, which also shows details of hook-up for this new type of mud separator. (Wm. F. Lowe in *National Petroleum News*, vol. 22, no. 32, Aug. 6, 1930, pp. 46–47, 2 figs., *d*)

POWER-PLANT ENGINEERING (See also Petroleum Engineering: Methods of Securing Cool Water)

Chemicals for Clarifying and Recovering Engine Condensate

THE purpose of using chemicals is to remove the oil found in engine condensate. This oil cannot be removed by ordinary filters as it has been emulsified to a degree where it is practically in solution, and the only way to remove it seems to be by causing it to coagulate, which, among other things, can be done by the addition of a chemical to a condensate water. Among other materials suitable for this purpose are soluble salts of aluminum, such as aluminum sulphate, and of iron, such as ferrous sulphate, both of which form a gelatinous precipitate which entangles the finely divided particles of oil and permits their removal by filtration. To make the additions effective, some alkali, such as lime or soda ash, has to be added also.

Aluminum hydroxide is soluble in both acids and alkalis; therefore, in order to obtain the best results, it is necessary to maintain the proper degree of alkalinity in the water. Successful operation, however, is not so dependent upon minimum solubility as upon its physical properties. The principal factor is a good "floc," that is, a precipitate of aluminum hydroxide which will form quickly in comparatively small flakes, and at the same time settle rapidly and filter easily. This condition is essential in order to obtain the most effective removal of oil.

Inasmuch as the condensate, after having been freed of oil, is to be utilized as a boiler feed, it is important that the correct proportions of aluminum sulphate and soda ash be employed. The proper dosages can be readily ascertained if the operator will understand and keep in mind the following points: Aluminum sulphate forms aluminum hydroxide and sulphuric acid in water. Soda ash reacts with the sulphuric acid to form soluble sodium sulphate and soluble sodium bicarbonate. From this it is apparent that the filtered and purified condensate should give alkaline reactions with both methylorange and phenolphthalein. The latter indicator is necessary to indicate that the soda ash used is slightly in excess of the amount required to neutralize all the sulphuric acid, and to prevent any free sulphuric acid or aluminum sulphate from entering the feedwater.

Since the proportion of oil in the water is somewhat variable, it is impossible to have a fixed dosage of chemicals. This must be secured entirely from experimental data, and adjusted to meet the requirements of the water being purified. A simple and entirely logical rule to remember is: "Other things being equal, the more oil to be removed, the more coagulant must be employed for its removal."

Essential requirements of a machine to do the work as outlined above may be briefly stated as follows: There must be intimate mixture of chemicals and condensate; the flow through the machine must be sufficiently slow to permit of rapid settling of the floc, and the filter must be of sufficient size to handle continuous runs of 12 to 24 hr. between washings. (A. W. Talbot and E. W. Pace in *Power Plant Engineering*, vol. 34, no. 13, July 1, 1930, p. 746, *p*)

A Nearly Manless Boiler Plant

THE boiler plant of the new foundry of the General Steel Castings Corporation at Eddystone, Pa., is intended to supply only heating and process steam, as all power is purchased from

outside. It is primarily remarkable for the fact that although of large capacity it employs normally only two men—a shift engineer and a helper. No other labor or supervision is required beyond an occasional visit by the power engineer, whose office is a quarter of a mile away. Of course, if needed, repair and maintenance gangs from the manufacturing plant are available.

The heating load far exceeds the process load, as shown by the fact that the winter steam peak of 1,500,000 lb. per day drops to around 340,000 in the summer. The chief demand for process steam is for the atomization of fuel oil in the various furnaces.

The small number of men employed is made possible by several design features. The entire plant may be controlled from a single location, with few exceptions, by push buttons and regulators on the central control board, or by handwheels directly in front of it. On the same board are indicated or recorded all plant data needed for intelligent operation. Other factors making for ease of operations are extreme visibility, cleanliness, and provisions for the comfort and effectiveness of the operating force.

Steam is furnished by two 7092-sq. ft. boilers, with space for a third unit. They are of the inclined water-tube type, designed for 200 lb. pressure but normally operated in the range from 125 to 150 lb.

Firing is from the back, with two burners per boiler for normal operation. Each boiler has its own unit mill. In addition, a third small mill to supply either boiler through a third burner for the light summer load has been installed. The maximum plant load in summer reaches 16,000 lb. of steam per hr., requiring the operation of one boiler at 70 per cent of rating. As the manufacturing plant grows, a third boiler until will be installed in space already provided. The average summer load of 12,000 lb. per hr. requires a rating of between 50 and 60 per cent on a single boiler.

A combination of water walls and air-cooled walls provides suitable protection for high ratings without overcooling of the flame. The furnace is fired from the back, with water-cooled walls front and back. Air admitted to the sectionally supported side walls goes to the mill as required. Air stacks from the walls to the top of the boiler room insure an ample flow of air at all times and carry away the excess not delivered to the mills. All plant auxiliaries are motor driven with the exception of the feed pumps, which are duplex reciprocating units. Induction motors, 440-volt, are used throughout except for the induced-draft fans, which are driven by direct-current motors with drum-switch speed control. Coal and ash handling is entirely mechanical. Coal is carried by a flight conveyor from the track hopper to a hammer-type crusher and reduced to $^3/_4$ in. It is then elevated from the basement to a belt conveyor distributing to overhead bunkers. This equipment may be operated by push button from the basement, and also from a point above the bunkers. Interlocking devices insure proper sequence in starting and stopping.

Coal for each boiler is pulverized by a single unit mill whose capacity ranges from 1500 lb. to 8000 lb. per hr. A third small mill arranged to supply either boiler for summer loads has a capacity of 750 to 3000 lb. per hr. The pulverizers, as already indicated, draw preheated primary air from the side walls of the furnaces. Control of mills and exhauster fans is by push buttons.

Hydraulic sluicing of ashes contributes largely to the general cleanliness of the plant and simplifies operation. Fly ash from the third pass of the boiler runs by gravity to the sluiceway. Ash and water are discharged to a sandy pit near the plant. This drains rapidly, and at the present rate will take years to fill up with ash. Sluicing water is furnished by a 250-ft.-head centrifugal pump driven by a 100-hp. motor. (P. W. Swain, Assoc. Editor of *Power*, in *Power*, vol. 72, no. 11, Sept. 9, 1930, pp. 412–416, illustrated, *d*)

High-Pressure-Boiler-Feed Systems

THE author considers briefly the maintenance problems of high-pressure boilers as connected with the matter of feedwater, and discusses feedwater treatment, air in the feed, and theory of corrosion. He recommends, in particular, the use of a closed feed system and discusses three such systems, one of which, shown at *A*, Fig. 2, would prevent feed contamination, but is not elastic enough to work on variable load. The system shown at *B* works along the lines of a closed tank installed between the extraction pump and the boiler-feed pump. In order to prevent the admission of air and to give elasticity to the system the tank was steam sealed, but in practice the tank merely filled up, after which it became virtually an enlargement in the pipe line and feed system similar to *A* and lost its elastic properties.

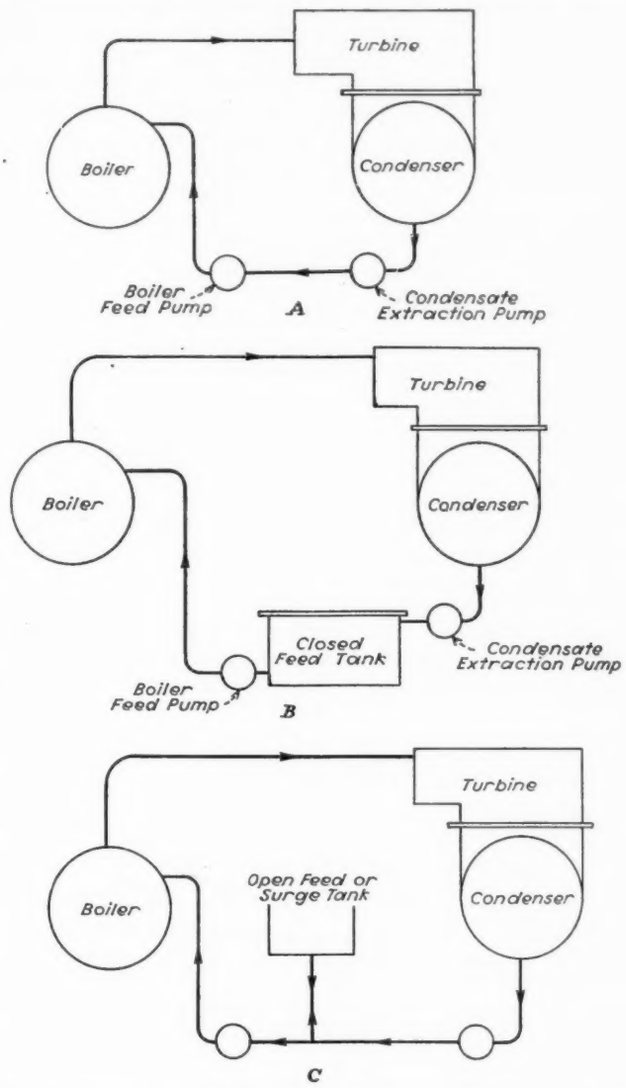


FIG. 2 DIAGRAMS OF THREE TYPES OF CLOSED FEED SYSTEMS FOR HIGH-PRESSURE BOILERS

Sketch *C* shows the open feed tank reinstalled but in an elevated position, and in this position it is generally referred to as a surge tank. This arrangement is adopted in practice and is quite a useful one; in fact, it may be said to mark the next step toward a true closed feed system. In this system the main body of the

feed is not exposed to the atmosphere and the tank serves to accommodate the surges or variations in the rate of flow of the feed, forming a receptacle for the surplus feed when the extraction-pump output is in excess of the feed-pump requirements, and making up the shortage when the reverse state obtains between the extraction and feed pump. The defect in this system, however, is encountered when there is a large shortage of feed in the system, resulting in a heavy draw-off from the feed tank. When this occurs there is a very real danger of air finding its way into the feed system.

The ideal closed feed system is one which, while being entirely closed, provides an elastic factor capable in practice of accommodating the fluctations in the rate of flow. This can be accomplished by automatic valves operated or controlled by floats which rise and fall with predetermined water levels at the points in the system where the floats are installed, and thus record the need for additional water or the discharge of surplus feed and at the same time give the necessary impulse, directly or indirectly, to the valve governing the immediate requirements. Additional feed from the open tank, on entering the system, passes to the condenser, and thus comes under the deaerating influence of the vacuum. Already it has been shown that the complete liberation of air and gases is only accomplished when a natural boiling point is reached; this being so, it will be readily appreciated that the deaerating efficiency of a condenser is a maximum when the temperature drop—that is, the difference between the temperature of the incoming steam and that of the outgoing condensate—is nil. In modern high-vacuum condensers of efficient design the temperature drop is seldom more than 1.5 to 2 deg. fahr. at the load for which the condenser is designed. It will thus be seen that before any additional feed from the open tank actually joins in the feed circulation, it has had an opportunity, while in the condenser, to throw off the air which it absorbed while exposed to the atmosphere.

The author also briefly discusses various deaerators and criticizes their operations. (D. G. McNair in *Electrical Times*, vol. 77, no. 2017, June 19, 1930, pp. 1235–1237, 2 figs., *d*)

PUMPS (See Special Machinery: A 10-In. Pump Sand and Gravel Dredge)

REFRIGERATION

Cooling and Heating With One Unit

IN THE apparatus shown in Fig. 3, *A* is a compressor and condenser; *B*, an air cooler; *C*, an electric fan; *D*, an outside air duct and regulator; *E* an air-suction pipe; *F*, a cold-air discharge pipe; *G*, a ventilator pipe; and *H* an electric motor. The accumulation of cold at constant temperature is provided by the freezing of a mixture of glycerine and water. The original article gives costs for such a plant in Belgian units. (Paper by Emile Guarini, formerly Professor of Electrotechnics in the School of Mechanical Arts, Peru; presented before the Belgian Society of Electricians in Brussels, and abstracted through *Ice and Cold Storage*, vol. 33, no. 386, May, 1930, pp. 122–123, 2 figs., *d*) (Figure on right-hand column.)

SPECIAL MACHINERY (See also Fuels and Firing: Grinding Tests With a Simple Tube Mill)

A 10-In. Pump Sand and Gravel Dredge

THIS is an electrically powered hydraulic pump dredge for the production of commercial sand and gravel aggregates operated by the Hugo Sand Co., Kent, Ohio. It is unusual both from the point of view of attention to design and the materials used.

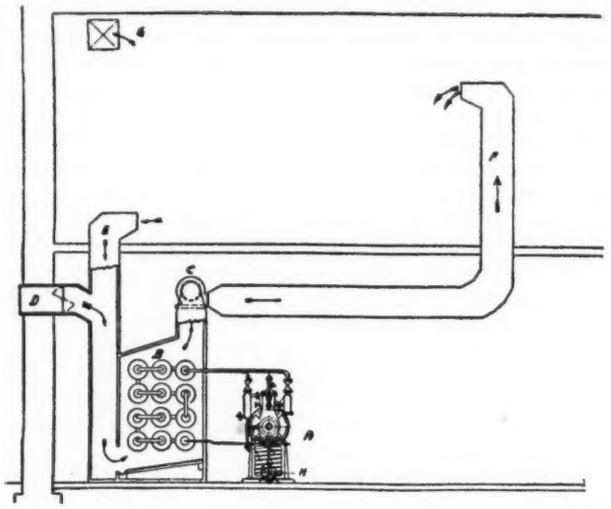


FIG. 3 DIAGRAMMATIC ARRANGEMENT OF AN ELECTRIC REFRIGERATOR WHICH CAN BE USED AS A HEATING UNIT

A 10-in. Amsco type-H, heavy-duty dredge pump with a full marine-type thrust bearing is used for the production of materials. The water-end parts are all made of manganese steel, accurately machine finished where necessary to assure correct fit when replacements are required. The shell is of snail design, the side plates are provided with renewable liners, and the stuffing box has a large water-seal chamber. The impeller is accurately balanced and attached to its shaft by tapered bore and auxiliary lock nut. It is directly connected to a 250-hp. General Electric 40-C slip-ring motor of 505 r.p.m. full-load speed, for electrical characteristics of 3-phase, 60-cycles, 440 volts; having controls providing for 50 per cent speed-reduction variation, continuous-duty type. A No. 18 Francke full-flexible coupling is used between the shafts of the pump and motor. The pump incorporates high-efficiency hydraulic-design features, giving high discharge-pipe-line pressure and maximum vacuum-creative ability for suction pipe line. The pump and motor unit with its electrical controls provides extreme flexibility over a wide range of operating total-head conditions. It is quickly responsive to the operator's demands, and is a well-synchronized installation as to characteristics of power and speed.

The hull pipe-line fittings, like the 45-deg. elbow with its handhole and cover plate next to the pump-section pipe-line opening, the nipple next to the pump discharge-pipe-line opening, and the flap valve of enclosed design, are all of standard 10-in. Amsco design, made of manganese steel to insure maximum wear service.

The dredge is designed for used in a quiet inland body of water where no currents of heavy wave action from winds are anticipated. All construction is of wood—full-length pieces of pressed fir. The A-frame is of special design of heavy timbers, with joints made with steel gusset plates bolted in place. It acts as a truss-yoke frame tying the pontoons together. The power line runs directly from the hoist drum on the hull to a lead sheave which guides the line to a triple block at the ladder bail position, from where it leads to a double block mounted on the A-frame head block. The arrangement employed provides for a six-part line and it is said produces correct reefing of the hoisting line and at the same time dispenses with any twisting of blocks.

To aid in working certain types of deposit banks met with by sluicing, the dredge mounts an auxiliary high-pressure water pump, electric-motor powered. A pipe line conveys the water pumped to a monitor mounted on the left forward pontoon.

The dredge is capable of digging materials varying in maximum depth below pond water level from 40 to 45 ft. The vertical lift of the discharge pipe line has varied from 35 to 50 ft. with the discharge-pipe-line lengths varying from 200 to 800 ft. From the dredge to the shore point, the discharge pipe line is supported on pontoons which, in turn, carry the 3-wire power-line system from the shore transformer station to the dredge. (Bradley S. Cart, Manager, Pump Dept., American Manganese Steel Co., Chicago Heights, Ill., in *Rock Products*, vol. 33, no. 15, July 19, 1930, pp. 67–69, 4 figs., *d*)

SPECIAL PROCESSES

Removal of Oil and Grease From Metal Parts

THE author discusses various methods employed for this purpose, with special relation to chemical methods. These latter he classifies into solvent, alkali, and emulsifying means. As to solvents, he lists gasoline, oil, benzol, carbon tetrachloride, and trichlor-ethylene. The disadvantage of the first three lies in their fire danger, and also in the fact that prolonged inhalation of gasoline or benzol affects the health of the workmen. Both carbon tetrachloride and trichlor-ethylene are free from fire danger, but are not safe hygienically except where the cleaning takes place in an entirely enclosed circuit.

As regards alkaline materials, they are free from the disadvantages of the solvents, but, particularly when used hot, are apt to cause burns if touching human skin and are particularly dangerous for the eyes. Moreover some of these materials corrode the metal. Emulsifying materials for removing fats and oils appear, therefore, to be the only ones safe and convenient in practice. The material which the author discusses in particular consists of a mixture of water glass and tri-potassium phosphate. Most of the manufacturers of these materials add to the above either caustic soda or potash lye and sell it as bi- or mono-silicates in concentrated form. The trouble with these preparations is that at times they are apt to produce an excessive alkaline reaction. Moreover the fact that they come in liquid form is also considered to be a disadvantage. Quite lately a mixture of water glass with mild tri-potassium sulphate has been placed on the market in Germany in powder form.

The author investigated the action of this material on metal coated with various oils. To do this the piece so coated was exposed in the air for eight days and then dipped in a boiling vat of the cleaning solution. It has been found that with various fats and oils the time required for cleaning varies from 6 min. to 2 hr., which would indicate that the reaction which takes place here is not one of saponification but of emulsification, as further proved by the fact that certain oils supposed to be easily saponifiable required a longer time in the bath than did mineral oils.

Practice with the cleaning material has indicated that the best effects are obtained when it flows over the piece to be cleaned, or, in general, where there is a relative motion between the two. (Dr. Hermann Stadlinger in *Chemiker Zeitung*, vol. 54, no. 37, May 7, 1930, pp. 354–355, *d*)

The Tetralin Process for Cleaning Gas Pipes

GAS pipes can be easily protected from external corrosion, but the matter of protecting them from internal corrosion is as yet in the development stage. Internal corrosion is due to the presence in the gas of small amounts of oxygen, carbon dioxide, and water vapor, in addition to which trouble may be caused by the presence of naphthalene in the gas, as this latter easily separates out of the gas and forms a bulky deposit which rapidly reduces the useful diameter of the pipe.

The author briefly considers some of the processes used in the past, and comes to the conclusion that all of them have certain important defects. His opinion is that the tetralin process gives so far the best results. This process consists in injecting a very small amount of tetralin into the gas before the latter is admitted to the distributing pipe, thus permitting the tetralin vapor to be carried to the farthest parts of the pipe system.

Tetralin is a clear, colorless, easily flowing liquid, and boils at 207 deg. cent. It is produced from naphthalene, a by-product of gas manufacture, by hydrogenation, which causes the naphthalene to pass from the solid to the liquid state. Tetralin is an excellent solvent for nearly all organic materials, and can hold in solution large amounts of naphthalene. Tars and pitch dissolve freely in tetralin. Its vapor is powerfully absorbed at rusty places. Tetralin inhibits rusting in iron articles, and makes leather soft and pliable.

All of these properties of tetralin make it very suitable for the cleaning of pipes and their protection against internal corrosion. Soon after tetralin vapor has been added to the gas a softening of hard deposits is observed. Moreover tetralin has the capacity of taking up from the gas the last stages of benzol. Tetralin may be added in two ways, by evaporation or by fine atomization when cold. If the latter process is employed, a small auxiliary compressor is required. This compressor uses gas from the mains as the atomizing fluid. It is claimed that the cost of the application of the tetralin process is extremely low. When the process is first applied, from 6 to $6^1/_2$ pf. worth of tetralin has to be used per 100 cu. m. of gas (0.4 to 0.5 cent per 1000 cu. ft.). After the first cleaning effects have been produced the amount of tetralin may be cut about in half, and it is claimed that after the process has been worked for some time continuously, $^1/_2$ pf. worth of tetralin per 100 cu. m. of gas is all that is required. The cost of the application of the tetralin process is low where the gas is distributed under pressure. This is due to the fact that as the partial pressure of a material is independent of the total pressure in the space in which evaporation takes place, very small amounts of tetralin in proportion to the volume of gas under pressure under which it is used, need only be employed. It is stated that the apparatus for the use of the tetralin process is patented in various countries by a German concern. (Dr. G. Weissenberger in *Petroleum*, vol. 26, no. 33, Aug. 13, 1930, pp. 855–857, *d*)

STEAM ENGINEERING

A High-Pressure Steam Engine With Opposed Pistons

THE author attempts to show that a steam engine, very nearly theoretically perfect, can be built with an extremely small clearance space if opposed pistons are employed. By compressing a mixture of wet steam obtained by injection of atomized water into a part of the exhaust steam, it has been possible to arrive at a cycle in which only the heat of superheat for each working cycle has to be supplied anew, and thereby a degree of utilization of heat has been attained which is equal to that found in the Diesel engine.

In the body of the article the author claims that, if properly built, the reciprocating steam engine will show a better utilization of heat than a steam turbine. He claims that if dry saturated steam of 40 to 60 atmos. abs. pressure is superheated to 500 deg. cent., supplied to an engine where it is expanded adiabatically to 0.1 atmos. abs., and then the steam in the region of wet steam is compressed at constant pressure by means of water injection and finally brought back to its initial pressure

adiabatically, such a process will give a heat economy of about 50 per cent. This process is represented in the temperature-entropy diagram shown in Fig. 4. Line 1–2 is the superheat; 2–3 the adiabatic expansion, in the course of which the saturation line is crossed; 3–4 is the heat removal at constant pressure; and 4–1 is the adiabatic compression to the initial state.

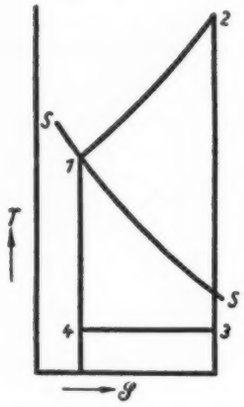


FIG. 4 TEMPERATURE-ENTROPY DIAGRAM OF THE CYCLIC PROCESS OF A HIGH-PRESURE OPPOSED-PISTON STEAM ENGINE

Hitherto it appears to have been impossible to carry out such a cyclic process in a reciprocating steam engine, particularly with one working cylinder. In order to make this process possible it is absolutely necessary to have the clearance space smaller than has been possible to obtain up to now, but the employment of opposed pistons which at the dead centers came to within 2 or 3 mm. (0.08 or 0.12 in.) of each other has solved the problem. Moreover, if disk valves are used, so arranged that they open outward, this in its turn makes it possible to reduce the clearance of two pistons with a stroke of 1 m. to 0.002 or 0.003 of the stroke volume.

The engine is shown in its main essentials in Fig. 5 and with some of the auxiliaries in Fig. 6. *a* and *b* are the opposed pistons. The very small clearance space (2 to 3 mm.) must be held constant by means of an automatic device. The admission valve *c* for the highly superheated high-pressure steam is driven by the crankshaft, and the cut-off is regulated by a governor in accordance with the output of the engine. On the lower side of the cylinder opposite the admission valve is the exhaust valve, which is likewise a disk valve. Contrary to the practice with ordinary steam engines, this exhaust valve is held open for longer or shorter periods in accordance with the output of the engine. The valve port, however, is very much smaller than ordinarily made and is limited in time to the inner dead center of the working piston. In order to facilitate the flow of steam in and out, the cylinder jacket is somewhat cut away in the immediate neighborhood of the valve.

In the median plane of the cylinder are located water-injection nozzles, which spray the liquid in the form of an extremely fine mist to the right and left in the longitudinal direction of the cylinder. The construction of these nozzles is similar to that of the fuel nozzles of compressorless Diesel engines. In Fig. 6, *d* is the pressure water pump which injects cold water taken from cooler *e* in exactly measured amounts and at the right instant under a pressure of 150 to 200 atmos. The amount of water injected is likewise controlled by the governor in accordance with the output of the engine.

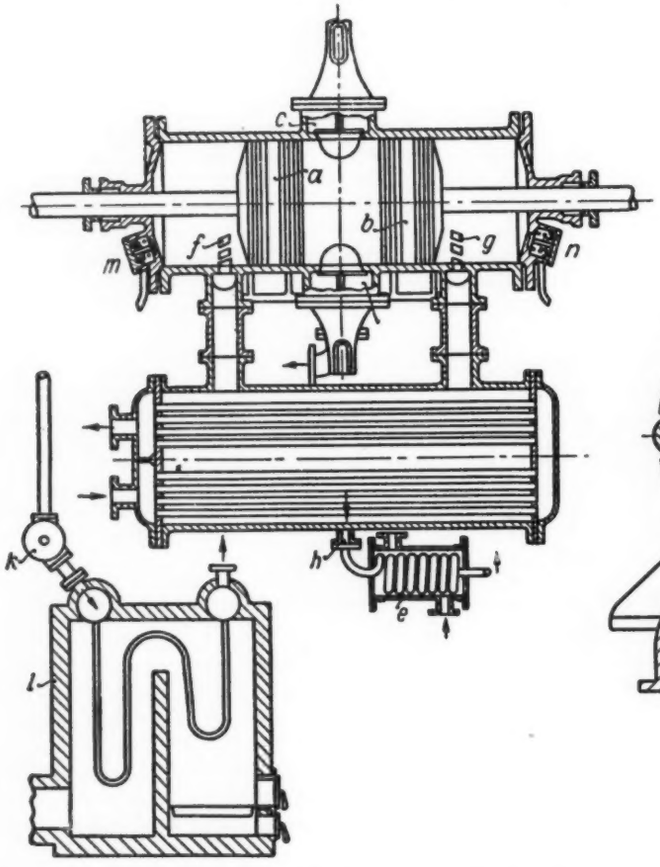


FIG. 5 STEAM ENGINE WITH OPPOSED PISTONS, LONGITUDINAL SECTION

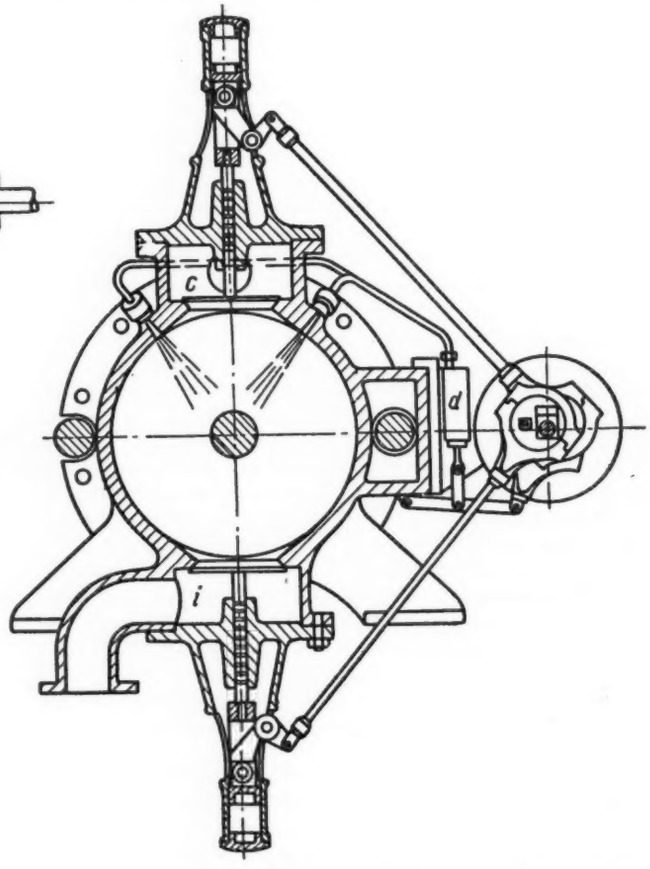


FIG. 6 CROSS-SECTION OF OPPOSED-PISTON STEAM ENGINE, SHOWING WATER-ATOMIZATION AND INLET AND OUTLET VALVES

On the right and left ends of the cylinder openings *f* and *g* are provided which permit part of the working steam to pass to the surface condenser. The condensate leaving the condenser at *h* is cooled to as low a temperature as possible in the cooler *e* and then delivered to the pump *d* to be injected into the cylinder

again. A part of the working steam, however, remains in the cylinder and is compressed through absorption of heat by injection of water, and finally expelled through exhaust valve *i* in the form of dry saturated steam. The arrangement of inlet and exhaust valves on the same side of the cylinder is justified also in view of the temperature of the steam, as the exhaust steam is reheated by compression to its initial pressure. From the exhaust valve this steam with about the same pressure as the boiler steam goes to an auxiliary pump *k*, which produces a slight increase of pressure, and after passing through the super-

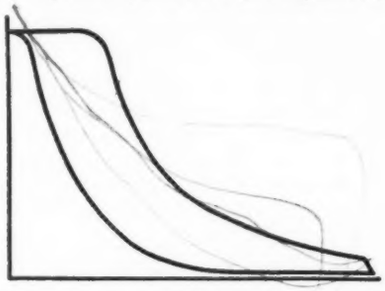


FIG. 7 INDICATOR DIAGRAM OF ENGINE SHOWN IN FIGS. 5 AND 6

heater *l*, the steam resumes its original cycle. The portion of the stroke between the slots *f* and *g* and the cylinder heads acts as a wet-air-pump space for the condenser.

In the forward stroke of the piston the cylinder receives from the condenser vacuum steam through the slots. The remainder which contains air is caught between the cylinder heads and the pistons, and escapes into the atmosphere as soon as sufficient pressure has been built up to overcome the spring-loaded deaerating valves *m* and *n*.

The cycle of operations for one revolution of the crankshaft is as follows: The two pistons move from their inner dead centers outward and while this is being done the superheated high-pressure steam is admitted to the cylinder up to a cut-off point determined by the output of the engine. The exhaust valve is then closed, and the steam expands until its pressure is just above that in the condenser. The result is that when the exhaust ports are reached the amount of steam corresponding to this excess of pressure passes over into the condenser. From this point on an amount of water weighing approximately the same as the steam lost to the exhaust is injected in the form of a fine mist into the cylinder, and the result of this is that the compression which the injection produces takes place at approximately constant pressure, and, after the end of this injection, is approximately adiabatic. This compression is carried to such an extent that the initial boiler steam pressure is approximately reached. At this instant the exhaust port opens and the wet steam flows into the superheater after a further increase in pressure given to it in an auxiliary pump. The auxiliary pump *k* is intended merely to compensate for the small loss of pressure due to the motion of the steam, and is driven all the time from the crankshaft of the engine. In order that the clearance space shall be supplied at all times with superheated and not with compressed wet steam, the exhaust valve remains open even after the admission valve has been opened to admit the first flow of steam. The pressure required to expel the wet steam completely is supplied by the auxiliary pump. The loss of heat involved in this operation, even when only live steam is used, is unimportant as the wet steam has ultimately to pass through the superheater. In normal operation of the engine the wet steam should be perfectly dried by the compression. When working at an overload the evaporation of some of the water added to the steam has to take place in the superheater. Since however, steam can carry quite a large amount of moisture, the above-described working process is capable of handling considerable changes in load. As only a part of the working steam is condensed in the condenser, it is possible to obtain a very high vacuum with a small amount of cooling water. The heat losses through the piston bodies can be minimized by the use of proper insulators. The indicator diagram is of the type shown in Fig. 7. The greatest part of the output is due to the large volume of superheated steam. The adiabatic of the superheated steam is seen to be much steeper in the expansion than the compression line of wet steam. Obviously the process can be used in two stages as well. The maximum pressure can then be carried to more than 100 atmos., in which case the superheater for the low-pressure cylinder would be built as an intermediate superheater. If the process is used in two stages with superheated steam at a pressure in excess of 100 atmos. and 500 deg. superheat, it should be possible to obtain a heat utilization in excess of 50 per cent. (Prof. K. Baetz, Würzburg, in *Die Wärme*, vol. 53, no. 31, Aug. 2, 1930, pp. 585–587, *dtA*)

THERMODYNAMICS

A Mean-Temperature-Difference Chart

THE increasing use of heat-exchanging apparatus in a great variety of applications is one of the important developments in engineering. In order to design a heat exchanger with the maximum performance in the transfer of heat, having due regard to weight, size, and cost, it is essential to use the logarithmic mean temperature difference in the calculations. This is, unfortunately, a laborious task, and also one which, if not carefully carried out, is a source of error, with the result that a large proportion of engineers use the simple arithmetical mean temperature difference as being a quickly obtained result not requiring the use of logarithmic tables. The latter method, in a large proportion of problems, is inaccurate to a considerable degree. By means of the accompanying chart, however, the logarithmic mean temperature difference can be read off from the actual temperatures without any calculations.

The chart (Fig. 8) is suitable for use in connection with heat exchangers, whether coolers or heaters, in all problems lying within its temperature range. An important feature of the chart is the graphical representation, by means of two diagonal lines, marked "oil" and "water," respectively, in the left-hand lower corner, i.e., in the third quadrant, of the lines or conditions of flow. These enable the actual temperatures to be correctly located relative to each other, whether contraflow or parallel flow, without any risk of error.

Assuming that it is required to obtain the logarithmic M.T.D. in the case of an oil cooler, given the inlet and outlet temperatures of the oil and water, the procedure is as follows:

The four temperatures are located on the scales indicated by the two diagonal lines, and horizontal and vertical lines are then projected from these points to intersect in the second and fourth quadrants. From the two points of intersection, the diagonal lines in the quadrants are followed until they intersect the ordinate and abscissa, respectively, of the first quadrant. By projecting horizontally and vertically from these points, a point of intersection will be determined in the first quadrant, and the logarithm of the mean temperature difference can be read off on the curved line on which this point is found to be.

As an example, it may be assumed that it is required to obtain the logarithmic mean temperature difference in the case of a contraflow oil cooler in which the inlet and outlet temperatures of the oil are 151 deg. fahr. and 65 deg. fahr., while those of the water are 46 deg. fahr. and 58 deg. fahr. Since the cooler is of the contraflow type, the temperature of the entering water will be located on the abscissa of the second quadrant, as indicated

by the arrow showing the direction of flow on the diagonal water line. The required point is indicated at *A*. The location of the other temperatures, *B*, *C*, and *D*, is obvious, and if the procedure described above is followed out, as indicated by the dotted lines on the diagram, the logarithmic mean temperature difference, in the case stated, will be found to be 46.7 deg.

By using the chart to the scale given, the logarithmic mean temperature difference may be obtained within an accuracy of about 2 per cent, which is sufficient for many purposes. If a higher degree of accuracy is required, the chart may be enlarged photographically or by other means. It will be readily understood that the chart is equally applicable to any scale of temperature, since it is based on Grashof's equation. This equation may be written:

$$\text{M.T.D.} = \frac{(T_1 - t_0) - (T_0 - t_1)}{\log_e \dfrac{(T_1 - t_0)}{(T_0 - t_1)}}$$

where M.T.D. = mean temperature difference
T_1 = temperature of oil at inlet
T_0 = temperature of oil at outlet
t_1 and t_0 = inlet or outlet temperatures of the water, respectively, according to the direction of flow.

It may also be pointed out that the chart is equally applicable to any two fluids, other than oil and water. (R. Johnson in, *Engineering*, vol. 130, no. 3370, Aug. 15, 1930, p. 213, 1 fig., *p*)

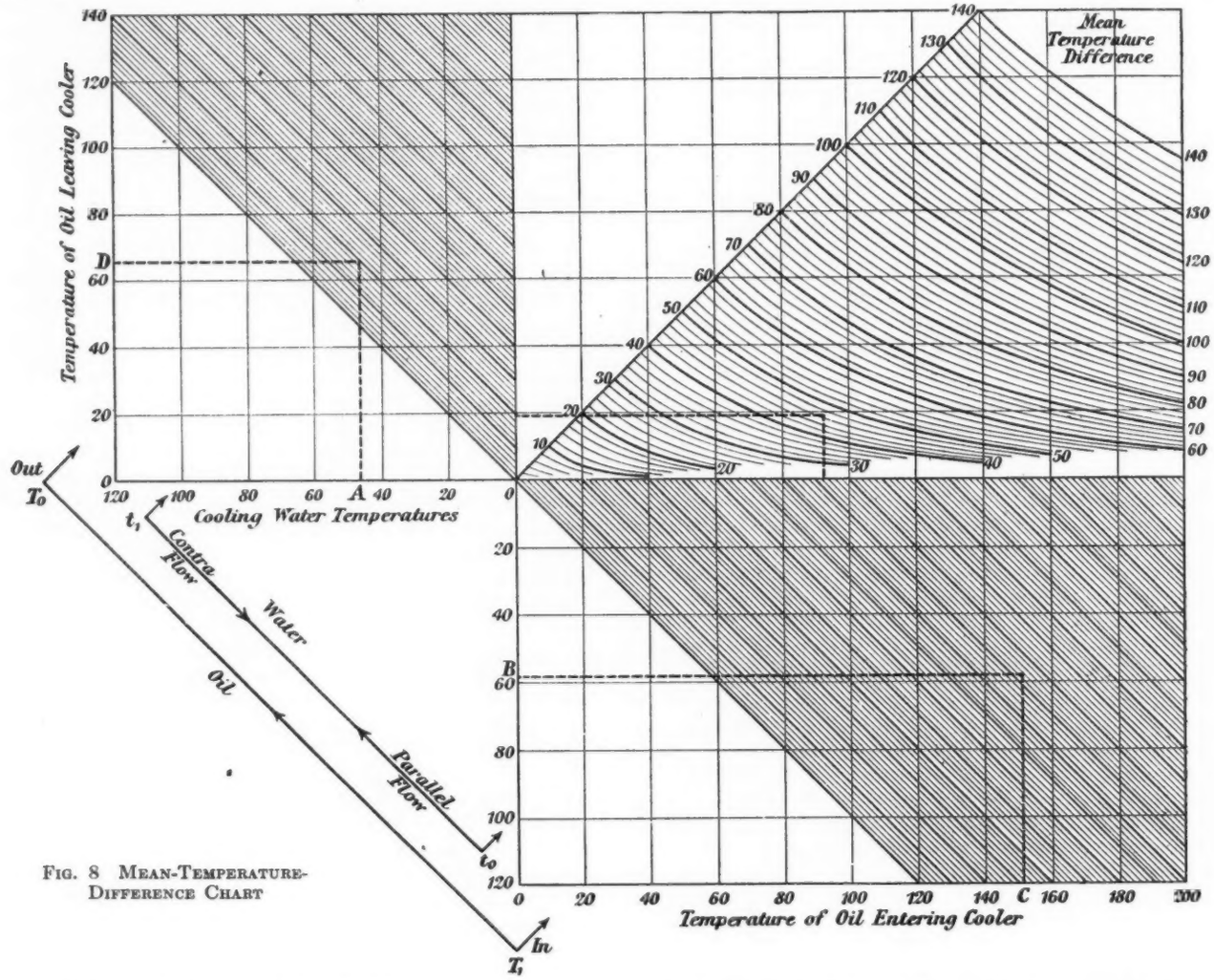


Fig. 8 Mean-Temperature-Difference Chart

VARIA

Physical Properties of Hot Cement

THE Building Research Station of the Department of Scientific and Industrial Research in England made an investigation of the physical properties of hot cement. The heat in question is that generated in the cement in the process of grinding, particularly when it is finely ground. Mills often deliver consignments directly to the job, and the question has occurred among users as to whether the cement which arrived on the site appreciably hot to the touch (as high as 140 deg. cent.) retained its full physical properties in that condition. The results of the test showed that hot cement can be safely used under ordinary conditions. (*Engineering*, vol. 130, no. 3376, Sept. 26, 1930, p. 411)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

Engineering and Industrial Standardization

Railroad Standardization Effects Economies in Europe and America

STANDARDIZATION of locomotive-boiler parts is effecting savings not only in time lost by locomotives during repairs, but also in labor requirements, and in reduction of motive-power requirements, according to an article in the April, 1930, issue of the *Boiler Maker*. Because of the fact that each plate, casting, or forging is designed complete in every detail, even to the last rivet hole, and that the location of every hole is fixed, each part when assembled fits exactly with those adjacent to it and will serve equally well on any boiler of its class. In the case of replacement parts, particularly those required after years of service, this is especially important. Such sheets or parts may be fabricated miles from the locomotive, and when assembled in position will fit exactly. Enormous reduction of shopping time for repairs is, of course, the result.

Not only is this problem of boiler repairs being overcome in the United States, but England is also considering the situation from the standpoint of standardization, according to an article in the *Times Trade Supplement* (London), as follows:

> This system has been extended to cover even such large items as boilers, and if an engine is stopped requiring extensive boiler work, this part is simply taken out and replaced by another of the same type standing ready. With such procedure it follows that either standardization must have been carried to a considerable length, or the stock of spare boilers will necessarily tie up a large capital sum. If standardization has not extended far, and it is recognized that capital must not be locked up in this way, the time under repairs must become extended. It is the nice balancing of these factors which adds much interest to locomotive work, and with the large amount of data available regarding repairs to be expected, life, and relative costs, such matters can be worked out in railway service in great detail.

Progress is being made in Great Britain in a larger program of railroad standardization as well. Economies effected by the railroads through standardization amounted to about £6,000,000 in 1928, which was maintained in 1929 as well. Four groups of railroads are now operating in Great Britain in place of the 120 different undertakings which existed seven years ago. Committees have been set up by these groups to standardize the railway stock of the country. According to the article in the *Times Trade Supplement:*

> Where it has not been possible to secure a common standard for all the companies, each has adopted its own, and group standardization has helped to reduce expenditure. One result of standardization has been that less capital is now locked up in spare parts. A large number of spare parts can now be ordered at a time, while interchangeability of parts has reduced the time rolling stock is out of commission for repairs.
>
> The standardization of locomotives has meant an immense saving. On amalgamation each group found itself in possession of a large number of antiquated engines, and some of these were expensive to run. There are now comparatively few different types. One company had no fewer than 60 different types of cars and these have been reduced to 23.

In Germany, the locomotive industry organized its own technical standardization committee (the General Locomotive Standards Committee) in 1927. In cooperation with the Railway Administration and the Industrial Standardization Committee, this committee has undertaken work on the standardization of locomotive parts for all gages, and for all locomotives.

Track Bolts and Nuts

THE seventh standard developed by the Sectional Committee on Standardization of Bolt, Nut, and Rivet Proportions deals with Track Bolts and Nuts. This standard, having received the approval of the Society of Automotive Engineers and The American Society of Mechanical Engineers, is now before the American Standards Association for approval as an American Standard. C. W. Squier, Associate-Editor of the A.S.M.E. publications, is chairman of the subcommittee which prepared this standard.

During the development of this standard, practical tests were carried on by the railroads and manufacturers on sample bolts made to the dimensions of the proposed standard, and at the May, 1930, meeting of the American Railway Engineering Association, it was adopted as a recommended practice of that body.

Pipe Flanges and Fittings

DURING the past five months the subcommittees of the Sectional Committee on the standardization of Pipe Flanges and Fittings have been active so a number of new proposals in the form of dimensional standards are now under consideration.

A proposed American Standard for Steel Base-Fittings has been recently released by Subcommittee No. 3 on Steel Pipe Flanges and Flanged Fittings, and it is now being distributed for criticism and comment. This proposed standard, which has the approval of the manufacturers, is not complete in itself but must be treated as a supplement to the American Standard for Steel Pipe Flanges and Flanged Fittings (A.S.A. B16e–1927).

At the present time a proposed American Standard for Pipe Plugs of Cast Iron, Malleable Iron, Cast Steel or Forged Steel is being distributed also in tentative form to industry for critical review. This standard, as proposed by Subcommittee No. 2 on Screwed Fittings has the approval of the manufacturers for use in connection with the American Standards for 125-Lb. and 250-Lb. Cast-Iron Screwed Fittings and the American Standard for 150-Lb. Malleable-Iron Screwed Fittings.

Should the readers of MECHANICAL ENGINEERING desire to make a detailed study of these proposed standards, copies may be obtained by addressing a request to C. B. LePage, Assistant Secretary, A.S.M.E., 29 West 39th Street, New York, N. Y.

The proposed American Standard for Steel Companion Flanges has been on the way for three years. In December, 1929, a questionnaire was sent out by the initiating subgroup of which J. Roy Tanner is chairman. The response to this inquiry was very full and prompted some revision of the preliminary draft of the proposed standard. A revised draft was fully discussed by the members of Subcommittee No. 3 on Steel Flanges and Flanged Fittings when it met in New York on October 24, 1930. This proposal will go next to the members of the Sectional Committee for discussion at a meeting, after which it will be voted on by letter-ballot.

A member of the American Petroleum Institute's Committee on the Standardization of Refinery Equipment has made a request of the Sectional Committee on the Standardization of Pipe Flanges and Fittings to the effect that it consider the

advisability of setting up American Standards for cast and forged steel flanges designed for welding to pipe. The request was made definite by the filing of a set of proposed dimensions for (*a*) Forged Type of Welded Flanges for 150, 250, 400, and 600 lb. pressure at 750 deg. fahr. temperature and (*b*) Forged Steel Companion Flanges, slip-on and Double-Welded, for 100 lb. pressure at 750 deg. fahr. temperature.

Mechanical Standards Advisory Council

THE second general meeting of the Mechanical Standards Advisory Council will be held in the Engineering Societies Building, 29 West 39th Street, New York, N. Y., on Friday, November 28, 1930, at 2:00 p.m. The principal business of this meeting will be a discussion and development of a proposed program for standardization activity in the mechanical industries for the calendar year of 1931.

In the May, 1930, issue of MECHANICAL ENGINEERING the conditions which prompted the formation of this Council and its plan of organization and function were discussed at length. Since that statement was made, however, the following four organizations have taken membership in the Council: Society of Terminal Engineers, Grinding Wheel Manufacturers' Association of the U. S. and Canada, the Refrigerating Machinery Association, and the American Foundrymen's Association. These additions raise the membership from the twenty-one organizations reported in May, 1930, to twenty-five.

The Executive Committee of the Council is of the opinion that the agreement on the basic purpose of the Council—"What and When to Standardize"—was prompted by a realization of the economic and satisfactory results to be derived from the utilization and coordination of the research and technical resources within the mechanical industries.

These resources, in the form of time, knowledge, experience, and financial support are available in a limited amount from the representatives of the member-organizations of the M.S.A.C. The Executive Committee is of the opinion, therefore, that the M.S.A.C. can render a valuable service to all branches of the mechanical industries, particularly in this period of economic stress and readjustment, if it can assist the organizations and firms supporting standardization in planning the allocation of their services to the movement.

In some branches it may be that the number of standards already completed warrants a temporary delay in the development of standards, thus permitting activity in the way of promulgation and adoption of approved standards. Such a procedure may foster even added confidence in the future of standardization under the American Standards Association. In other branches of the industry it may be that standardization has been viewed with alarm through lack of confidence in the possibility of ways and means for developing and introducing standards and the advantages to be derived from such expenditure of effort and money.

It is hoped that the discussions at this meeting will afford the member-organizations which are cooperating in the development of projects now on the A.S.A.'s calendar an opportunity to collaborate with respect to the urgency of their completion. Possibly one result of the meeting will be the setting up of a priority value for these projects in the mechanical field.

A request for the organization of a technical committee to undertake the standardization of foundry equipment under the auspices of the American Standards Association will be acted upon at the next meeting of the A.S.A. standards council. The request was made jointly by the American Foundrymen's Association, and The American Society of Mechanical Engineers.

NEW AMERICAN STANDARDS

The following standards were approved by the A.S.A. during the months of August 15–October 15, 1930:

Code for Lighting: Factories, Mills and Other Work Places, A11, 1930. (American Standard.)

Sponsored by the Illuminating Engineering Society. Published by the Illuminating Engineering Society.

Safety Code for Installation of Pulverized-Fuel Systems, Z 12a-1927. (American Standard.)

Sponsored by the National Fire Protection Association and the U. S. Department of Agriculture. Published by the N.F.P.A.

Specification for Dry Cells and Batteries, C 18-1928. (American Standard.)

Sponsored by the Bureau of Standards. Published by the Bureau of Standards.

Standard Insulator Tests and Ratings, C 29a-1930. (American Standard.)

Sponsored by the American Institute of Electrical Engineers and the National Electrical Manufacturers Association. Published by the A.I.E.E.

Motion-Picture Standards, Z 22-1930. (American Standard.)

Sponsored by the Society of Motion Picture Engineers. Published by the S.M.P.E.

Method of Test for Distillation of Gasoline, Naphtha, Kerosene, and Similar Petroleum Products, Z 11j-1930. (American Standard.)

Method of Test for Water and Sediment in Petroleum Products by Means of Centrifuge, Z 11h-1930. (American Standard.)

Method of Test for Burning Quality of Mineral Seal Oil, Z 11r-1930. (American Standard.)

Method of Test for Burning Quality of Long-Time Burning Oil for Railway Use, Z 11s-1930. (American Standard.)

Method of Test for Burning Quality of Kerosene Oils, Z 11q-1930. (American Standard.)

Method of Test for Distillation of Natural-Gas Gasoline, Z 11k-1930. (American Standard.)

Method of Test for Viscosity of Petroleum Products and Lubricants, Z 11b-1930. (American Standard.)

Method of Test for Water in Petroleum Products and Other Bituminous Materials, Z 11i-1930. (American Standard.)

Method of Test for Detection of Free Sulfur and Corrosive Sulfur Compounds in Gasoline, Z 11u-1930. (American Standard.)

Method of Test for Cloud and Pour Points of Petroleum Products, Z 11e-1930. (American Tentative Standard.)

Method of Test for Melting Point of Petrolatum, Z 11v-1930. (American Tentative Standard.)

Method of Test for the Determination of Autogenous Ignition Temperatures, Z 11w-1930. (American Tentative Standard.)

Sponsored by the American Society for Testing Materials. Published by the A.S.T.M.

Instruments and Apparatus

Preliminary Draft of Part 20 of Code—Smoke-Density Determinations

The Main Committee on Power Test Codes takes pleasure in presenting to the members of the Society for criticism and comment Part 20, "Smoke-Density Determinations," of "Instruments and Apparatus." The Individual Committee which has developed this draft consists of Messrs. C. F. Hirshfeld, Chairman, W. A. Carter, Secretary, C. M. Allen, E. G. Bailey, L. J. Briggs, C. R. Cary, J. D. Davis, R. E. Dillon, F. M. Farmer, J. B. Grumbein, W. H. Kenerson, E. S. Lee, E. L. Lindseth, O. Monnett, S. A. Moss, R. J. S. Pigott, and E. B. Ricketts.

The "Instruments and Apparatus" Section will consist of twenty-one parts dealing with the following subjects: (1) General Considerations,[1] (2) Pressure Measurement (6 chapters),[2] (3) Temperature Measurement (9 chapters),[3] (4) Head Measurement, (5) Measurement of Quantity of Materials, (6) Electrical Measurements,[4] (7) Mechanical Power, (8) Measurement of Indicated Horsepower, (9) Heat of Combustion, (10) Chemical Composition (4 chapters), (11) Determination of Quality of Steam,[5] (12) Time Measurements, (13) Speed Measurement,[6] (14) Mechanical Measurements, (15) Surface Area, (16) Density, (17) Determination of Viscosity of Liquids,[7] (18) Humidity, (19) Concentration of Dilute Solutions, (20) Smoke-Density Determinations, and (21) Leakage Measurements (2 chapters).[8]

Complete copies of the draft which is published here in abstract may be obtained from the Society's headquarters. The Individual Committee, the Main Committee, and the Society will welcome suggestions for corrections or additions to this draft from those who are especially interested in this subject. These comments should be addressed to the Chairman of the Committee, in care of The American Society of Mechanical Engineers, 29 West 39th Street, New York. N. Y.

TABLE OF CONTENTS

	Paragraph
General	1
Bryan Donkin's Smoke Chart	5
Eclipse Smoke Indicator	8
Eddy Smoke Recorder	11
Ringelmann Chart	17
Roberts Smoke Chart	26
Sawford's Smoke-Density Meter	30
Umbrascope	35
Westinghouse Smoke Indicator	40

[1] See MECHANICAL ENGINEERING, February, 1923.

[2] Chapter 1 of Part 2, on "Barometers," was published in the November, 1927, issue of MECHANICAL ENGINEERING.

Chapter 6 of Part 2, on "Tables, Multipliers, and Standards for Barometers, Mercury and Water Columns, and Pressure Measurements," was published in the July, 1928, issue of MECHANICAL ENGINEERING.

[3] Chapter 1 of Part 3, "General," was published in the December, 1925, issue of MECHANICAL ENGINEERING.

Chapter 5 of Part 3, on "Pyrometric Cones," was published in the August, 1930, issue of MECHANICAL ENGINEERING.

Chapter 6 of Part 3, on "Glass Thermometers," was published in the April and May, 1926, issues of MECHANICAL ENGINEERING.

Chapter 7 of Part 3, on "Pressure-Gage Thermometers," was published in the October, 1928, issue of MECHANICAL ENGINEERING.

[4] See MECHANICAL ENGINEERING, December, 1928.

[5] See MECHANICAL ENGINEERING, June, 1930.

[6] See MECHANICAL ENGINEERING, April, 1929.

GENERAL

1 The purpose of this section is to describe the various methods for measuring smoke density that may be of use in connection with power-plant tests. It must expressly be understood that no attempt is made to specify the density at which smoke may or may not become a nuisance or violation of an ordinance. This is a legislative matter in the hands of the various municipalities, and entirely beyond the provisions of the present work.

2 Measuring smoke is at present a rather intangible process. So much depends on the personal element, character of background, direction of wind, charts and instruments used, and other factors that it is difficult to establish standards at the present state of the art. One of most common objections to present methods is that smoke-density measurements with all known methods, except one, are affected by the diameter of the stack or gas stream in the case of a breeching. All readings might be referred to a standard diameter, but no such standard has yet been suggested in this country and the practical difficulties in the way of fixing such a standard are enormous. Readings should therefore be interpreted with judgment, based on local conditions, and have in mind the duty performed by the plant.

3 The qualitative determination of the density of smoke emitting from a stack is made by using one of the following charts or instruments:

Bryan Donkin's Smoke Chart
Eclipse Smoke Indicator
Eddy Smoke Recorder
Ringelmann Chart
Roberts Smoke Chart
Sawford's Smoke-Density Meter
Umbrascope
Westinghouse Smoke Indicator.

4 Of these, the Ringelmann chart is probably the most used at the present time, and will therefore be discussed in detail. The general remarks, however, apply to the other charts and instruments as well.

RINGELMANN CHART

17 *Description.* The Ringelmann chart, as developed by Professor Ringelmann, has come into extensive use for the purpose of measuring smoke, being used as a basis for determining the various densities in most of the smoke ordinances of the country. In theory the chart is divided into five grades or densities called Nos. 1, 2, 3, 4, and 5, the densities varying in 20 per cent gradations, No. 1 being 20 per cent dense or equivalent to 20 per cent black; No. 2, 40 per cent dense; No. 3, 60 per cent dense; No. 4, 80 per cent dense, and No. 5, 100 per cent dense.

18 The regular chart, 26 × 12 inches in size, as published and used by the U. S. Bureau of Mines, is illustrated in Fig. 4[9] in reduced size, and consists of four printed rectangles corresponding to Nos. 1, 2, 3, and 4 densities, No. 5 not being in-

[7] See MECHANICAL ENGINEERING, March, 1930.

[8] Chapter 1 of Part 21, on "Condenser Leakage Tests," was published in the November, 1925, issue of MECHANICAL ENGINEERING.

[9] Not reproduced here.

cluded. These printed rectangles are covered with black lines which obscure a percentage of the white surface corresponding to the density it is desired to indicate.

On the No. 1 chart the black lines are 1 mm. wide and 10 mm. apart, leaving spaces 9 mm. square.

On the No. 2 chart the lines are 2.3 mm. wide with spaces 7.7 mm. square.

The No. 3 chart has lines 3.7 mm. wide and spaces 6.3 mm. square.

The No. 4 chart has lines 5.5 mm. wide and spaces 4.5 mm. square.

19 In using the chart, it is set up directly in line between the observer and the stack which is to be read, and at a distance of about 50 feet from the observer so that the density of the smoke emitted can be conveniently compared with the various densities as shown on the chart.

20 Observations are made at regular intervals, and the density of the smoke is recorded by the observer. The interval between observations for accurate work is generally 15 seconds, making four observations per minute, and the result of the observations is used according to the purpose for which the work is being done.

Information, as gathered by a Ringelmann-chart observation, may be used in various ways, according to the purposes for which the readings are being made. The usual purpose is to determine whether or not the stack under observation has violated the smoke ordinance. An observation of the stack over a period of an hour will give a record of the performance and show at a glance whether or not the stack has violated the ordinance, and also show the amount and density of smoke throughout the period of observation.

Another purpose of Ringelmann-chart observations is to determine the behavior of a stack over a period of time. If the stack is located in a territory in which smoke work is being done, it becomes necessary to know the density of the smoke at various hours of the day and on various days of the month. In this case a systematic program of observations over one-hour periods is laid out, which, when completed, give the extent and density of the smoke emitted throughout the period under investigation.

In addition to the information, as outlined above, a smoke-density figure is obtained by reducing all the smoke made over a period of observation to the equivalent of No. 1 smoke, which is 20 per cent dense. Dividing this by the number of observations gives the average density for the period, which figure can be taken to represent the performance of the stack and is comparable with other similar figures taken on that stack during other observations, thus furnishing a means of determining the improvement or otherwise in the performance of the stack. Fig. 5[9] is a sample form showing how this calculation is made. It will be noted that this figure takes into account all smoke made, whether inside or outside of the smoke ordinance, and is information distinct from the mere matter of whether or not the stack violates the ordinance. This information is used largely in testing the behavior of smokeless furnaces, and in determining the degree of efficiency attained when issuing certificates of operation by smoke departments as called for in some ordinances, and when conducting acceptance tests on furnace equipment, etc.

Another purpose for which Ringelmann-chart observations are useful is in determining the smoke density for an entire city or for dividing up the density made by different districts of the city, and for tabulating the performance of smokers in the various industrial and other classes of smoke producers. This information is collected with a view to future smoke-abatement programs. It has been found that smoke is a seasonal product. Most plants have their period of maximum smoke production and their corresponding slack period. This information properly tabulated, month by month throughout the year, furnishes a valuable aid to smoke workers in attacking the problem most effectively, and also furnishes a series of figures which show definitely year by year the progress made in smoke-abatement work.

The method of obtaining this information is to use the smoke-density figures obtained throughout the various seasons in connection with the tonnage of coal used for the territory under observation, and also the tonnage used for the various classes of smokers as determined by a fuel survey made at the time the density figures are being obtained. The procedure is then as follows:

The total amount of stack gases per ton of coal burned per annum is reduced from tons per annum to cubic feet of gas per minute.

Assume 20 pounds of gas per pound of coal and 25 cubic feet of gas to a pound; then $(2000 \times 20 \times 25)/(365 \times 24 \times 60) = 1.902$. This is taken as 2.00 for convenience in figuring: that is, for each ton of coal burned per annum, there would be two cubic feet of gas to be taken care of per minute. Then the coal burned per annum in tons times two would give the total gas per minute. This figure times the per cent density for the district gives the number of cubic feet of dense smoke per minute, which divided by the total cubic feet per minute equals the per cent of the total smoke made by the group or class under consideration.

21 In practice where a great many observations are being made, the chart itself is not generally used. An experienced observer, located at a central point of vantage, is usually reading smoke in a number of directions and covering stacks over a considerable territory. It would be impracticable under such conditions to locate charts to cover all situations. It has been found to be simple and easy for an observer to memorize the few grades or densities of smoke covered by the chart, and when once fixed in the mind, consistent results are obtained without the actual use of the chart. When training observers, however, the chart is used, and careful instruction is given until the various densities are memorized.

22 *Range and Accuracy.* As noted above, Ringelmann observations in practice are nearly always made without the actual use of the chart. This introduces the possible human-element error, as the observer depends upon his judgment in reading the densities. However, this has not militated against this method of observation, as the number of grades of densities involved is so small as to require little mental effort on the part of the observer. When careful results are required for comparative purposes, the same observer is assigned to cover the territory during the period of investigation. The character of the sky as a background and the general condition of the weather must be taken into account when taking density readings. The one big disadvantage of all but one of the present-day smoke-determination methods described herein is the inability to make observations after dark. See Par. 11.

23 When the Ringelmann chart is used as the basis for determining violations, No. 3 smoke is generally the density prohibited. This is called dense smoke. No. 3 smoke is equivalent to 60 per cent black, and is presumed to be so dense that the eye cannot see through it.

24 In making observations the density of smoke is taken directly across the top of the stack or as it emerges from the stack. The point of observation best suited is where the wind is blowing the smoke in a direction at right angles to the observer. The worst point of observation, and in fact one in which reliable results are impossible of attainment, is one in which the smoke is being blown directly toward the observer. Observations looking away from the sun are more reliable than when looking toward the sun. In the latter case, the densities are inclined to be read too heavily. The distance over which a reliable observation may be taken is quite flexible, especially in the case of stacks which have a clear sky for a background, in which case it is easy to read smoke for a distance of a number of city blocks.

25 In the use of the Ringelmann chart, density is the only factor considered. The color of the smoke has no bearing on the readings. The smoke may be dense gray, or yellow, or black.

ROBERTS SMOKE CHART

26 *Description.* The Roberts charts, illustrated in Fig. 6,[9] consist of disks having the same gradation as the Ringelmann chart; No. 1—20 per cent; No. 2—40 per cent; No. 3—60 per cent; No. 4—80 per cent; and No. 5—100 per cent dense. The disks have radial black lines on a white background. When

a disk is revolved a grayness results. The disks have an eyelet center, and can be spun on a bradawl, piece of wire, a nail, or other convenient shaft. Usually it is most convenient to hold the awl with the left hand, the disk vertical and facing the observer (the hand behind the disk). The disk is spun by a downward blow on its circumference, struck by the forefinger of the right hand.

27 For ordinary field work two disks (4.25 in. in diameter) are used, each having two grades, one on each side. For special field work, or for demonstration, a large disk (9 in. in diameter) is employed with each side graduated from No. 1 to No. 5. The grades on one side are in bands (see Fig. 6), and on the other side there is a gradual change, No. 1 being on the inside, No. 5 at the outside, and circles indicate the positions of Nos. 2, 3, and 4.

28 In making observations for best results, the light should fall on the chart from the same direction and in the same intensity as it falls on the smoke.

29 The chief advantage of the Roberts charts is the ability to use them close at hand, and as only one set of charts is required when observing several stacks from the same observation point, this is a decided advantage over the Ringelmann chart. The large chart likewise has an advantage over the Ringelmann in the case of demonstration, or in court.

SAWFORD'S SMOKE-DENSITY METER

30 *Description.* This instrument is based on the principle of the measurement of density or opacity of any medium to transmitted light, and the readings are interpreted in terms of percentage density; 100 per cent density being total opacity to light, and 0 per cent density being clear or offering no reduction in intensity of the transmitted light.

31 It consists of two principal parts, namely, the optical system, which is an apparatus for transmitting a beam of light through a portion of the smoke or gas to be measured, and a light-sensitive device to receive the beam of light after transmission; and the meter for indicating or recording the density, together with the current supply and control equipment. The general arrangement of the apparatus is shown in Fig. 7.[9]

32 The optical system is fitted to the stack or breeching in a suitable location for observing a representative sample of the gases, while the meter may be located in any convenient place for observation.

33 The light-sensitive device is a photoelectric cell which functions as a variable resistance whose resistance to current flow is governed by the intensity of the light shining upon the sensitive surface. When dark, the cell is a non-conductor, and the current flow through the amplifying tube is at a minimum.

34 The indicator is a high-grade milliampere meter. The scale is reversed according to the usual practice, that is, zero on the scale is at the right-hand side, reading around the scale to 100 per cent density at the left. The position of zero density is actually the full-load reading of the meter as a milliampere meter, the reading becoming less as the density of the gases increases. The recorder, designed for wall mounting, is of the clock-driven, strip-chart type.

WESTINGHOUSE SMOKE INDICATOR

40 *Description.* The main part of this instrument is the photoelectric cell, a device which translates light impulses into electrical impulses, the amount of current flowing through the photoelectric cell being directly proportional to the amount of light falling on it.

41 The photoelectric smoke indicator and recorder is shown schematically in Fig. 9.[9] The device consists of two main parts: first, the light-source unit and the photoelectric amplifier and control unit, mounted on opposite sides of the stack or breeching; second, the indicating and recording instruments, as well as the bell alarm or indicating lamp. The light-source unit consists essentially of a low-wattage incandescent lamp, a condensing lens for collecting the light rays into a parallel beam, which is projected through the stack, as well as adjustments for properly focusing this beam of light. The photoelectric amplifier and control unit contains the photoelectric cell on which, through a condensing lens, the beam of light sent out from the light source unit is focused. It also contains the amplifier unit.

42 *Operation.* Briefly, the scheme of operation is to project a beam of light through the stack or the breeching on a photoelectric cell. Depending on a smaller or greater density of smoke in the stack, the photoelectric cell receives more or less light, which causes a greater or smaller current to flow through the cell. This current is then amplified so as to be sufficiently large to operate standard instruments. The instruments are calibrated in degrees of smoke density as read on a Ringelmann chart.

Correspondence

CONTRIBUTIONS to the Correspondence Department of Mechanical Engineering are solicited. Contributions particularly welcomed at all times are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on its activities or policies in Research and Standardization.

Scandinavian Gang Saws for Closer Utilization of Timber

TO THE EDITOR:

Commenting on Mr. Oxholm's résumé of the present status of the series of experiments in the Scandinavian methods of sawing lumber,[1] with particular regard to those carried on at the Tumwater Mill at Olympia, Washington, as we understand the purpose of this entire series of experiments, they represent an effort to convert into merchantable lumber, or shook material, top logs or small-size timber running from a 10-in. top downward. The Tumwater experiments under discussion, however, deal with logs having an average diameter of from 12 to 14 in. This would compare favorably with such timber as Florida pine, Lake State hemlock, and some of the smaller timber in the Gulf States. A comparison of average practice in timber of this general size develops as follows:

The capacity of the two-gang mill at Tumwater is approximately the same as that of a two-band standard equipment. Saw kerf is approximately the same. No. 14 gage saws are standard equipment in both systems. Output per man is approximately the same. Two less men would be required in the pond with the band operation, two more men on the saw floor of the mill, making thirteen men in each instance on the sawing floor.

First cost of installation is approximately the same—about $12,500 per rig, assuming equal edging and trimming equipment.

Grading would be approximately the same, provided sawing method No. 2 were used with the gangs. Forty per cent overrun would be considered a splendid recovery in the band operation. Reports from the Tumwater operation indicate recovery in over-

[1] "Scandinavian Gang Saws for Closer Utilization of Timber," by Axel H. Oxholm. Paper WDI-51-14, Trans. A.S.M.E., September-December, 1929.

run of between 50 and 55 per cent. Is the superior recovery in overrun due to greater care in manufacture under test conditions, or is it inherent in the two methods of operation? The relative proportion of dimension and inch-board material has a bearing on this, but is not mentioned in Mr. Oxholm's paper.

Accuracy of manufacture as between the two methods would, in our opinion, be practically the same, provided the American practice of swaged teeth is adopted. The superiority of the European product in this respect is largely due to extreme skill in the handling of spring-set saws. American practice has depended exclusively upon the swage type of tooth. This is not capable of giving the same finish or the same accuracy. The cut of a swage tooth is a crushing and scratching process, so far as it relates to the side of the cuts, whereas the spring-set tooth, when properly made, gives a true shear cut for the side of the kerf. If the experiments now in process demonstrate that swage teeth must be used, we believe results in this particular direction would be approximately equal for the two methods of manufacture.

Do, therefore, the Tumwater experiments develop the true field of the Scandinavian gang? We believe they represent a median line where the two processes of manufacture are on approximately equal ground.

Larger timber would show an increment in favor of the band-mill operation. Smaller timber would throw increasing weight toward the Scandinavian system, based on the premise that handling and turning time with band-mill and carriage operation is approximately a function of the number of logs sawed per day, whereas the cutting capacity in actual cutting time is a function of the size of logs and depths of cut available. Further tests based upon timber averaging not to exceed 8 in. top diameter would be the utmost value. Possibly some of the other experiments mentioned may have developed this phase.

An interesting variant of the gang method of operation was developed in Florida some years ago, and was, we believe, first applied by the J. Ray Arnold Lumber Company, of Groveland. Several plants in that state were equipped with machinery for this process, the method used being as follows:

Small rough logs were brought into the mill and passed through what was known as a "cant machine," or colloquially as a "boll weevil." This machine consisted of two circular saws capable of being set to take off two slabs and a cant ranging in thickness from 3 in. to 10 in. The slabs made on the side cut were reduced on band horizontal resaws to board thickness. The cants were passed through rift machines, these being very wide machines equipped with a battery of saws for each thickness commonly cut. This method approximated the No. 2 method of manufacture mentioned in the complete report of the Tumwater operation. As circular saws were used throughout, except in the cutting of the wide slabs, no such percentage of overrun would naturally be obtained, but we understand that the Florida operators using this system found it a more profitable manner of handling their small rough logs than previous systems based on the use of band or circular saws and carriages.

Another variant of the same system was in use in some of the Minnesota mills about 1900, the slabbing cuts being made by twin band resaws. The C. A. Smith Lumber Company, of Minneapolis, was the most notable exponent of this system.

A search of the records of the United States Patent Office during the 70's and 80's shows the inventive minds in the lumber industry concentrating very largely upon elements of gang design. The type of gang design exemplified by the Scandinavian makers is what was known in the 70's as a straight or plain gang; that is, a gang with the saws hung at an angle without oscillation. These were very commonly used as round-log machines. The type of carriage used with the Scandinavian gang was known as a "bear trap," and the use of this type of cutting—a combination of the "bear trap" and the straight gang—was so common in the New England states that the type was known as a "Yankee" gang. This type of gang gradually gave way during the 80's to what was known as the "stock" gang, still manufactured and used in American mills.

The system of cutting before the advent of the band mill was very similar to the "tandem" method described in the Tumwater report, except that the gang was placed behind the circular mill. A few slab cuts were made and the remainder of the log passed through the so-called "stock" gang. This method gave, and still gives, in logs of common grade, the cheapest method of lumber manufacture yet developed. Yet the system has gradually disappeared in the smaller mills.

Its decline was coincident with the appearance of two new factors: first, the development of practical band-sawing machinery, and second, the development of various systems of lumber grading, which depended upon the percentage of clear cuts in the manufactured lumber. In general, in logs of commercial size, in softwoods, inch lumber in the better grades sells at a lower figure than 5, 6, 8/4, or thicker. The band mill produces a greater percentage of this class of material, and has flexibility enough to obtain the maximum thickness in maximum quality. In the common grades, round knots will set the value up a grade higher than will spike knots, and proper manipulation decreases the percentage of spike knots in the common grades.

These two factors, and the disappearance of the advantage in kerf previously enjoyed by the gang, led to its gradual disappearance in the smaller mills. Larger plants always secured a sufficient percentage of logs where these factors did not apply, to render the installation of a gang profitable. Therefore, in the South, or in the Lake States, with the notable exception of some mills specializing in rift flooring stock, the gang gradually disappeared from mills having a capacity of 100,000 ft. per day or less.

Gang design during this period largely progressed along the lines begun in the 70's. The attention of the American designer was concentrated on a comparatively short-stroke, heavy machine capable of handling a number of cants at a time at comparatively slow rates of feed. Some splendid machines have been produced along these lines. The Scandinavian machine of 20 in. stroke and about 40 in. wide between sashes weighs under 25,000 lb. The same machine as built by American makers weighs about 60,000 lb. The American designer invariably uses the oscillating type. Additional mass is necessary there to take care of additional vibration, and as a gang is essentially an unbalanced machine, each increase in weight has led to vexing problems in vibration, which have been countered by additional weight.

We know of one notable instance where one of the best gang designers ever produced in this country, broke entirely away from conventional practice and used a form of single oscillation, producing in that way a very successful light gang, but it did not seem to meet the fancy of the market.

Bearing in mind relative stumpage values, the small log of 8 in. diameter or less represents the same value now that the 12-in. or 14-in. log carried in the 90's. The entire American mill practice at present is based upon the profitable conversion of logs 12 in. or upward, leading to the conclusion that radical readjustments in milling practice are probably necessary to take care of the changed economic structure created by increased stumpage costs. The answer to this problem may be some form of gang or multiple sawing, or it may be in smaller-type band mills, with automatic or power dog carriages, with the ultimate aim in either case to decrease the labor cost per thousand feet on smaller sizes of timber.

The element of superior salesmanship, or better organization of the manufacturers using one method versus the other, may have more weight in determining the trend of manufacture than the

actual intrinsic merit of the two systems. We should criticize the absence of control experiments carried on under identical conditions: that is, in experiments such as those carried on at Tumwater, the data obtained should be supplemented by corresponding data obtained in usual American practice under identical conditions; and must reiterate that these experiments are inconclusive in that they are carried on in timber exceeding in size the admitted economical range for Swedish gang sawing.

R. LANGILL.[2]

TO THE EDITOR:

Commenting on Mr. Langill's statements, it should be borne in mind that his were made a year ago, and at that time the Scandinavian gang-sawing system had only been tried out in one plant, and consequently our experience with this system was limited. At the present time there are a number of standard mills on the West Coast that have installed these gang saws, and we are now in a better position to comment on the results obtained. Referring to the points raised by Mr. Langill:

The saw kerf of the Scandinavian gang saws has now been reduced, due to the operators' greater familiarity with the sawing of West Coast woods and improvements in saw-manufacturing methods to cover this particular use.

The output of standard Scandinavian gang mills on the Pacific Coast is now from 35,000 to 40,000 ft. per gang per shift of 8 hours when cutting Douglas fir, and from 40,000 to 50,000 ft. per gang per shift cutting hemlock. Considerable improvement has been made in the designing of these gang mills, and as a result we have found that the average daily output per man in recently constructed gang mills on the Coast is from 2800 to 4000 ft.

We have made no corresponding tests to ascertain the daily output per man in the band mills, but we know it is considerably less. These figures include all labor from log pond to loading lumber on cars or barges, but do not include planing-mill or dry-kiln operation.

In regard to the overrun, we have found that it is safe to figure on between 40 and 50 per cent on these gang-saw mills, basing the figures on Pacific Coast scale. These latter covering overrun were obtained during a long period of time and refer to ordinary working conditions. They confirm the figures obtained when the first mill at Olympia was tested.

We must bear in mind that there is one essential difference between band-sawing and gang-sawing operations: the lumber leaving the gang saw is practically a finished product and needs only to be edged and trimmed. But band-sawn lumber is only partly manufactured, since it must be resawn. The writer does not quite agree with Mr. Langill's opinion that the accuracy of manufacture of band-sawn and gang-saw number is about the same. For many years he has made a detailed study of the marketing of American lumber in the foreign field. Time and time again he has found that the foreign consumers objected to the inaccurate manufacture of American band-sawn lumber, and for this reason we have not obtained the prices for our stocks which we would have secured were the lumber better manufactured.

It is significant, therefore, that about two-thirds of the gang-sawn lumber heretofore produced on the Pacific Coast has been exported, and has successfully competed with gang-sawn lumber from Russia and Northern Europe. The term "inaccurate sawing" is of course a relative one, and there are undoubtedly many purposes for which accurately cut lumber is not absolutely essential. The writer has always considered accuracy of manufacture as one of the principal virtues of the Scandinavian gang-sawing system. It is also interesting to find that the mills using these Scandinavian gang saws have been in constant operation, and as far as we have been able to learn, they are making a profit.

The dimensions of the saw logs that can be profitably cut on gang saws is of course a matter for the individual operator to solve. The writer understands that there is a tendency on the Pacific Coast to go beyond the 20-in. top-diameter limit which was recommended in the original report. It is not possible from this end to lay down any hard-and-fast rules, since the cost of labor, the efficiency of the operator, and the cost of the raw material must be given consideration in each instance.

At the present time, the writer understands, one mill is being constructed on the Pacific Coast that will utilize logs 6 in. in top diameter and upward, making a specialty of the smaller sizes of saw logs.

The writer is not in a position to go into the matter of relative cost of gang-saw and band-saw installations, since this business is competitive, and so far there are no two mills that have used exactly the same equipment.

As the writer understands it, efforts are now being made to manufacture these saws in this country, and he is informed that of the total cost of equipment of the Scandinavian gang mill, about 80 per cent is for equipment of American manufacture. This refers to auxiliary machines, conveyor equipment, belting, etc.

In regard to the quality of gang-sawn lumber, it is interesting to notice that the operators have expressed themselves as very well satisfied on this point. While theoretically it would be possible to secure more clear lumber from a log under the band-sawing system, the greater overrun in connection with the gang-saw operation and the economies effected in labor and time of sawing, have compensated for this possible small disadvantage. It must also be stressed that the small logs cut on the gang saw contain a very small percentage of clear lumber, so this question is not particularly important.

In regard to swaged and set saws, it is true that the practice heretofore followed in this country has been to use the former. The set saw has its advantages, and the writer is still of the opinion that some time in the future the saw manufacturers will be able to turn out a spring-set saw for use in these gang saws that will still further improve the smoothness of the cut. The time is not ripe for such a change, but with increasing raw-material values the use of spring-set saws will unquestionably be considered.

In conclusion, the writer would like to point out that the National Committee on Wood Utilization introduced the Scandinavian gang-sawing system for the purpose of increasing the utilization of small logs which have been found difficult to convert on band saws. It is believed that we have succeeded in this undertaking. We have been met with a very liberal attitude on the part of the lumber industry and the sawmill-machinery industry. We have carefully pointed out in each instance that there is a limit to the usefulness of this equipment, and that we believe band saws are the most efficient equipment for the conversion of the larger logs. It now appears that the Scandinavian gang-sawing idea will gain ground, due to the constantly diminishing dimensions of saw timber.

That our sawmill engineers are not overlooking these conditions is proved by the fact that several sawmill-machinery concerns are now experimenting with special equipment for the conversion of small timber, and furthermore constant changes are being made in the design of the original Scandinavian gang saw in order to make it more suitable for American conditions. There must be no confusion, however, in regard to the character of the modern gang saw. It is as different from the old-type gang saw as is the modern automobile from the 1900 vintage.

AXEL H. OXHOLM.[3]

[2] Chief Engineer, Prescott Company, Menominee, Mich. Assoc. Mem. A.S.M.E.

[3] Director, National Committee on Wood Utilization, U. S. Department of Commerce, Washington, D. C.

The Conference Table

THIS Department is intended to afford individual members of the Society an opportunity to exchange experience and information with other members. It is to be understood, however, that questions which should properly be referred to a consulting engineer will not be handled here.

Inquiries will be welcomed at Society headquarters, where they will be referred to representatives of the various Professional Divisions of the Society for consideration. Replies are solicited from all members having experience with the questions indicated. Replies should be as brief as possible. Among those who have consented to assist in this work are the following:

ARCHIBALD BLACK, Aeronautic Division
A. L. KIMBALL, Applied Mechanics Division
H. W. BROOKS, Fuels Division
R. L. DAUGHERTY, Hydraulic Division
WM. W. MACON, Iron and Steel Division
JAMES A. HALL, Machine-Shop Practice Division
CHARLES W. BEESE, Management Division
G. E. HAGEMANN, Materials Handling Division
J. L. WALSH, National Defense Division
L. H. MORRISON, Oil and Gas Power Division
F. M. GIBSON and W. M. KEENAN, Power Division
W. R. ECKERT, Petroleum Division
MARION B. RICHARDSON, Railroad Division
WINFIELD S. HUSON, Printing Industries Division
JAMES W. COX, JR., Textile Division
WM. BRAID WHITE, Wood Industries Division

Wood Industries

Treating Wood for Use in Lining Refrigerator Cooling Rooms

WI-4 Coniferous, odorless woods are used as linings of refrigerator cooling rooms. How can these woods be impregnated in such a manner as to keep them from absorbing moisture and at the same time not impart an odor or create another undesirable condition?

Coniferous woods impregnated with paraffin or sulphur will not absorb moisture and should not be objectionable for use in lining refrigerator cooling rooms. Such impregnation, however, would probably be considered too expensive to warrant use under ordinary conditions.

On the other hand, it may be of interest to point out that wet or dry rot is caused solely by the action of fungus. Although moisture accelerates this action, it will not of itself produce decay. Lumber impregnated by the vacuum-pressure process with a sodium fluoride-dinitrophenol-chromate mixture will successfully resist decay in damp or humid locations and will serve the inquirer's purpose in the most economical way, provided his question was prompted by a desire to prevent decay. Lumber so treated is clean and odorless; in fact, apart from a slight yellow coloration, its properties are identical with those of untreated lumber. (Howard B. Carpenter, Process Lumber Co., Elizabeth, N. J.)

Miscellaneous

Conveying Sand Hydraulically

M-10 It is planned to convey sand from a washer to a height of 20 ft. above the washer by means of water injected at high velocity through a nozzle into a 5-in. pipe. Does this arrangement seem feasible, or will the quantity of water to be disposed of offset the advantages gained by the elimination of mechanical apparatus?

(*a*) On page 790 of the 1918 edition of Peele's Mining Engineers' Handbook is a cut and description of a hydraulic elevator which illustrates the idea of elevating sand pulp. Unless water under pressure is very cheap the method will be found quite expensive, as a 5-in. pipe would require in the neighborhood of 600 to 700 gal. per min. This pulp would probably again have to be dewatered in a dewatering cone after the pulp had been raised to the required height.

If sufficient submergence is available, an air lift could be used. Otherwise pumping with a rubber-lined pump would probably be the most efficient. These problems are all very common in ore-concentration mills. The method suggested in the question is probably the least efficient of any. (W. A. Ledell, El Paso, Texas.)

(*b*) In so far as the writer knows, jet elevators were first used extensively in the early hydraulic-mining days of the western part of North America, and in this application some quite large units were built, i.e., up to 16 in. diameter of throat. They were used where surface conditions necessitated that the ground broken by the hydraulic giants be elevated in order to provide the necessary height for tailings disposal. Later they were used to some extent for elevating material for the construction of hydraulic-filled dams.

The development of these machines was a "Topsy" affair, and very few reliable data on either design or performance are in existence. In fact, most units were simply built and used to the limit of their capacity under their particular operating conditions, and no reliable performance data were ever obtained, and little if any scientific effort was made to improve design.

While the principal application in the hydraulic-mining field was for the elevation of solids suspended in water, the same machines were frequently used for elevating water only to keep pits drained.

At best the mechanical efficiency of these elevators was low, but the first cost of the machines themselves as well as the upkeep was also low and they were comparatively foolproof, so when given a cheap supply of power water the hydraulic elevator was a very satisfactory machine in its peculiar field. In fact, the writer has often wondered if some one were to ask him to install equipment to elevate 3000 cu. yd. per day of a mixture of sand and gravel carrying boulders up to 12 in. diameter and 40 times its own volume of water to a height of 40 or 50 ft., and in such a manner that any gold or platinum it might carry would not be separated out and lost, would there be anything better to offer? The principle has been used for the past 30 years for elevating ashes to be ejected overboard from the stokeholds of coal-burning ships. Here is another application where improvement is doubtful.

The inquirer asks if "the dilution will be too great," and

ordinarily the answer to this would be "yes." However, the writer saw one case where a very small jet under about 700 ft. of head was used to transport screened sand about 25 ft. vertically and about 150 ft. horizontally from a sand pit to a bunker through a pipe about 4 in. in diameter. Ordinarily the sand arrived at the bunker quite wet, but as a matter of curiosity it was demonstrated that with careful feeding of the sand it would arrive at the top end of the pipe as a very thick pulp. This of course was an extreme case.

The writer first investigated the possibilities of this type of elevator in 1911, when the milling of low-grade copper ores on a large scale was just beginning to come into its own.

A battery of five belt elevators with 30-in. belt, 65 ft. center to center, running at about 500 ft. per min. belt speed and elevating a mill pulp that was probably about 25 per cent solids, and crushed through 10 mesh, was used. As nearly as could be determined, the mechanical efficiency was about 50 per cent, and the cost of upkeep, especially on belts, was high. Very little investigation caused the idea of a jet elevator to be discarded, and efforts were directed to improve belt-elevator practice. Eventually belt life was increased from three months to eleven months, but due to the spill of the buckets at the belt speeds used, the efficiency remained low, although very much above anything that could be hoped for from the jet type of machine.

Later other engineers on similar work adapted the air lift to the same class of work, with an appreciable improvement in operating convenience and upkeep cost over what could be hoped for from the belt elevators. The air lift had a short vogue in the field of large-scale milling operations when the Wilfley pump was introduced, and, generally speaking, it is the most desirable machine available today for elevating milling pulps or other mixtures of abrasive solids suspended in liquids.

Bulletins Nos. 134 and 128 of the Joshua Hendy Iron Works are about the only publications in existence giving real information on the hydraulic elevator and hydraulic giants. They are now out of print and the supply will soon be exhausted, but the writer will be glad to supply copies. (F. W. Collins, Joshua Hendy Iron Works, San Francisco, Calif.)

Miscellaneous

ETCHING NUMBERS ON THICKNESS GAGES

M-13 What is an inexpensive method of etching numbers on thickness gages? A rubber stamp dipped in acid has been tried, but with acid strong enough to etch the impression clearly, the rubber stamp is corroded.

(*a*) The following method is commonly used on small quantities of material which do not warrant the purchase of special transfers. This method can be used on flat-steel gages, milling cutters, and any special small tool or gage.

1 Spread a small thickness of beeswax over the area to be etched.

2 Write the sizes on the beeswax with a sharp scriber point, with just enough pressure to make sure that the metal surface is reached.

3 Apply a small quantity of nitric acid with a pointed piece of wood over the etched impression; by trial and smell one can tell when the acid has eaten far enough into the gage surface.

4 Sprinkle a copious amount of common table salt all over the beeswax; this will neutralize the acid.

5 Scrape off the beeswax and salt. A clear impression of the etching should be seen. By one or two trials, letting the acid burn for a minute, and by increasing or decreasing the time until the depth of impression is reached, very satisfactory etching is obtained. (Arthur H. Flockton, Jersey City, N. J.)

(*b*) Satisfactory etching may be done by simply coating the metal with paraffin and then removing it with an ordinary scriber or any other sharp steel tool. After preparation of this mask a few drops of hydrofluoric acid are poured on the bared metal which is to be etched. The acid attacks the metal portion which has been bared to receive the etching treatment, but it is repelled by the paraffin mask and so the numeral or design which was drawn with the scriber is etched.

Acquiring the proper technique of manipulation requires only a little practice. Of course, the usual precautions of working with acid must be observed. (C. Wagner, Denver, Colo.)

Questions to Which Answers Are Solicited

USE OF PULVERIZED COAL FOR FIRING SHAFT LIME KILNS

F-14 Has a direct-fired pulverized-coal system ever been used to fire shaft lime kilns? If so, give brief description, together with results obtained, difficulties encountered, and data on operation.

CUTTING A GROOVE IN HARD ROCK

M-14 How can a groove $1/2$ in. deep and from $1/2$ in. to $3/4$ in. wide be machined at one cut in hard rock at a speed of 60 in. to 75 in. per min.? What power will be required to operate the machine, and what material and shape are necessary for the tool?

USE OF METALLIC POROUS MATERIAL

M-15 It is desired to use a metallic porous material for an operation in which the contents of the metallic-porous-material vessel will be restrained, but gases extruded from the contents will be allowed to pass freely through the material. Some cast iron is quite porous enough for the purpose, but the porosity is accidental rather than intentional. Can cast iron be made definitely porous under proper control, and if so what method or principle is used? What, if any, other metals can be made definitely porous to gases under pressure?

DRUMMING NOISE OF BOILERS

P-5 Why do boilers make a humming or drumming noise at certain loads, and how may it be eliminated in any given installation?

USE OF STEAM ECONOMIZER

P-6 Is it economical to install a steam economizer in a stack serving a boiler which consumes approximately 500 tons of soft coal per year, and which carries a steam pressure of approximately 10 lb. of steam? The cost of the coal consumed is approximately $3000 per year.

CAUSES AND REMEDIES FOR CINDER CUTS IN BOILER FLUES OF LOCOMOTIVES

R-4 What are the causes and satisfactory remedies for cinder cuts in the flues of steam locomotives? They occur both inside the firebox above the firebricks at the boiler head and also in the front end or smokebox.

LATEST DEVELOPMENTS IN THE LONG-DRAFT SPINNING OF COTTON YARN

T-2 What are the latest developments in long-draft spinning of cotton yarn? Has any system of long-draft spinning been generally adopted in this country?

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers, and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

CHARLES PIEZ, *President*

ERIK OBERG, *Treasurer* CALVIN W. RICE, *Secretary*

COMMITTEE ON PUBLICATIONS:

W. A. SHOUDY, *Chairman* F. V. LARKIN

W. H. WINTERROWD L. C. MORROW

S. F. VOORHEES

C. E. DAVIES, *Secretary to Publications Committee*

PUBLICATION STAFF:

G. A. STETSON, *Editor*

FREDERICK LASK, *Advertising Manager*

Contributions of interest to the profession are solicited. Communications should be addressed to the Editor.

BY-LAW: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B2, Par. 3).

Arctic Discoveries

SIR HUBERT WILKINS' explanation last month to the members of the Engineers' Club of New York of the purposes of his submarine polar expedition, is likely to disturb the complacency of those who feel that such projects are mere foolhardy adventuring. The study of meteorological conditions in the Arctic which may have an important bearing on knowledge of weather in inhabitable parts of the world, will be possible only when stations can be manned and maintained on the polar ice hundreds of miles from terra firma. Demonstrating the practicability of a means of access to these stations is one of Sir Hubert's objects. At the same time it will be demonstrated whether or not there is a possibility of the successful use of submersible vessels plying trade routes under the ice that blocks the harbors of Hudson Bay and the White Sea during the winter months.

It is known that the ocean in the vicinity of the North Pole has a depth of more than 18,000 ft. and that the mountains at the South Pole are more than 18,000 ft. high. Sir Hubert will plot the contour of the bed of the Arctic Ocean, and thus determine more accurately the actual shape of the solid portion of the earth. By sampling the sea water he will have data on the contributions of northerly flowing rivers, many of which pass through little-known areas. Incidentally he will have an opportunity to discover how a gyroscope behaves at the pole.

All of these, and many others, seem to be projects of great scientific, economic, and humane interest and value. While the engineer's immediate attention is diverted by the technical details of the submarine and its operation, his imagination is stirred by the possible significance of the results the expedition hopes to attain, and he wishes the expedition success and the voyagers safe return.

Extratechnological Progressiveness

ENGINEERS, scientists, and other groups of persons having common intellectual interests are able to find a basis for mutual understanding, confidence, and respect which transcends the limitations imposed by race and country unless commercial or political prejudices and rivalries make themselves felt. The community of interest of engineers of all nations is an effective instrument of good-will and world peace until, through the passion of non-technological differences, a normally beneficent and constructive profession devotes itself to contentions and destructive purposes.

Baron Shiba, eminent Japanese engineer, at a luncheon last month given in his honor at the Engineers' Club in New York, spoke hopefully of beneficial contributions to prosperity and world peace that might be made through engineering cooperation. Such splendid evidences of cordiality, cooperation, and good-will as were displayed by Japanese engineers and their government during the World Engineering Congress held in 1929 in Tokyo lend support to the Baron's hopes for the future. Engineers should examine the philosophy of their profession as it relates to non-technological matters, and satisfy themselves that its growth keeps pace with the developments in the physical sciences. It would indeed be unfortunate if engineers, so quick to recognize and put into effect principles that researchers in science turn over to them, should be unsympathetic Bourbons in matters affecting the welfare of the race.

Confidence in Aircraft

USES for aircraft are constantly demanding attention. An eastern university is transporting instructors to classes that cannot so conveniently assemble at the university's headquarters on the theory that time is saved and that it is better for a few instructors to travel than that a large class should make the long trip.

Another use for airplanes, pointed out by Clarence Young of the Department of Commerce, is by salesmen covering large territories where the distances between towns make this means of transportation economical of their time. Mr. Young reports that some companies are equipping their salesmen with planes as they equipped them with automobiles a decade ago, and are teaching the men to fly.

Friends of aeronautics will wish these ventures success, and hope that they will be carried out with such adequate provisions for safety and with such carefully made studies of their feasibility that their failure on account of either of these factors has been insured against. The economic situation of the aeronautical industry today is not as favorable as it was two years ago. Public confidence in the future of aviation is increased as more commercial uses are found for it, and makers of planes and engines are heartened by these evidences of faith. But the industry and its promoters must provide guarantees that individual failures do not undermine the growing confidence in this new service of rapid transportation.

Photography of Sound

FILMS recently received in this country show photographs of sound waves taken in the laboratory of Baron Shiba in Japan at speeds as high as 40,500 exposures per second. This is the beginning of a truly new method of analysis of phenomena to which insufficient attention has been paid in the past.

Speaking before the International Association for Testing Materials in New York City in 1912, the late Professor Howe pointed out the value of sound as a method of determining the behavior of structures, and predicted that the day might come when engineers would report that a skyscraper did not properly respond to a given note.

Two difficulties are encountered in analyzing sound: First, the extreme complexity of the wave forms, a general noise being a combination of several higher harmonics; and second, the impermanence of sound and the very imperfect mechanism with which nature has endowed man to receive it. The human ear is capable of distinguishing only a narrow range of sounds, and yet at low frequencies, and especially below the audible ones, many sounds of engineering importance are emitted. In the study of noise as a physiological factor, it is important to recognize that extremely high inaudible vibrations may be capable of producing a distinct and possibly an important physiological effect.

When a proper method has been developed for photographing sound waves, it will be possible to examine the records of a given noise, break the latter up into its component harmonics, and analyze these, for example, by means of an integraph or some similar device. Some day it may be possible to say that an airplane propeller emits a certain note because of the distinctive curvature of its blade or the degree of freedom of vibration of its tips. The remarkable results already obtained with high-speed photography in the examination of the action of rifle bullets makes the new development of sound photography by extremely rapid exposures one worthy of serious attention of engineers.

Control of Unemployment

IN MOST countries of the civilized world today serious unemployment exists. France is an exception, but even there the recent introduction of the "talkies" has, according to newspaper reports, thrown 500 musicians out of work.

This form of technological unemployment has been brought to our attention in this country by advertisements protesting against "canned" music, advertisements, ill-advised in the opinion of some, that musicians themselves have inserted in papers and magazines.

Who shall survive the competitions of modern life? We sympathize with the deposed musician because we ourselves may stand tomorrow in his place, our functions in the social economy having been usurped by some mechanism of our own creation.

Engineers are familiar with sudden economic displacements and readjustments because they are close to them and frequently responsible for them. They have even been known to work themselves out of jobs, although they are usually fortunate enough to create greater opportunities for their services. Hence they are seldom heard to complain about it, thinking that in the long run, results are in line with progress.

Enforced unemployment for technological reasons is nothing new, but it strikes more frequently and affects more people in an industrial society influenced by rapid progress in the physical sciences than it did generations ago when change was less rapid. It is not likely that we shall be able to lessen these changes or the rapidity with which they take place. It is not probable than we shall wish to do so. In the infinity of the future the curve of progress may become asymptotic. At present the slope of it, whatever its complete form, seems steep.

Adaptability is essential to survival and is a guarantee to security. But with the adaptability of the individual and of society itself must come a greater element of intelligent control. Until the social machine reaches a destructive speed there is still time for the governor to function, but if there is no governor or if its action is faulty, there will be serious need for an engineer. Engineers can assist in the solution of a serious world-wide problem of exercising intelligent control in cases of technological unemployment that come within their jurisdiction.

"Civil Engineering"

TO *Civil Engineering*, the new monthly magazine of the American Society of Civil Engineers, which made its first appearance in October, we extend our heartiest congratulations and sincerest wishes for success. If the quality, both physical and editorial, of the first issue is any indication of what future issues are to be like, there is little doubt but what President Coleman and the Publications Committee will find the society whole-heartedly behind them in their new project; and advertisers, who make their first contact with the A.S.C.E. in this medium, will discover an approach to readers of selected quality that will greatly appeal to them.

What the journals of engineering societies may hope to accomplish with clearly defined ideals and purposes, competent administration, and friendly support by the individual and official representatives of the societies, is only being approximated at the present time. Without doubt, these journals are frankly instructive. If they are conceived of as merely another means of spreading technical literature among engineers, it is hard to understand why their functions cannot be as well performed by privately owned periodicals, leaving, for the moment, the sections devoted to society affairs out of consideration, or by the *Transactions* that all of the societies also publish.

The journals of engineering societies are the focal points of the professional interests of the engineers they reach, and the interpretative mediums by which engineering is related to the other phases of human culture and contemporary progress. They should provide the means which no other type of journal can apply so effectively by which engineers, having widely diversified technological interests and professional functions, may find themselves and their work brought into proper perspective with other engineers and their works and with the great forces—economic, technological, sociological, political, and cultural—which are molding contemporary civilization and affecting the destinies of men and nations. If this seems to be an ambitious function, it is none the less important, and if it is not performed by the journals of engineering societies, it is not likely to be performed by any other form of publication.

In fulfilling its function, therefore, the engineering-society journal must exercise a high degree of professional leadership and imbue its readers with the broader significance and value of their work. Thus within its pages will coalesce the elements of a fine contribution to human progress. The American Society of Civil Engineers is adding to its already distinguished record of services to mankind an evidence of vigorous leadership in the common purposes of its members as men and citizens as well as engineers.

When a Material Becomes Cheap

THERE are a number of materials which are not used because their cost of production is excessive or their availability limited. This was the case, for example, with phthalic acid, which sold at several dollars a pound. Then a process was developed which brought its price down to a matter of cents, and new and important uses for it were found.

Two other materials seem to be reaching this stage today. One of these is diphenyl. An interesting feature about this substance is that it boils at a temperature considerably above that of water but does not decompose at that temperature,

which makes it possible to use it in boilers and possibly in jackets of automobile engines in competition with ethylene glycol which has been recently used experimentally in airplane engines as a cooling medium.

Another material of the same class is beryllium. The supplies of beryllium ore, particularly in Europe, appear to be quite large, but until quite recently the process of extracting the metal was a very complicated and expensive one, with the result that the metal was more or less a chemical curiosity. Vigorous work is going on in the direction of finding commercial ways of recovering this metal, and the most recent information would indicate that these efforts either have been or soon will be crowned with success. It is not quite certain yet what improvement beryllium is capable of producing in light alloys, but there is no question about its ability to improve very materially the properties of heavy alloys, particularly those containing nickel, chromium, and cobalt.

Science, in particular chemistry, seems to be like a huge building with an enormous number of doors, some of them wide open and others carefully locked. The problem of the research man is to find keys to the locked doors. It is arduous work at times, but such is the prodigality of nature that it is practically certain that if a key to a door is found, something worth while will be discovered inside. As far as the engineer is concerned, all he has to do is to watch the chemists and physicists at their tasks, and then apply the results of their discoveries in his own great field; and woe to the engineer who does not keep posted on what is going on in the realms of chemistry, physics, and—today—even in such apparently irrelevant sciences as astronomy and biology.

Good Out of Russia?

WHAT are engineers to think of the conditions in the world's markets brought about by the introduction at prices below the costs involved of raw and manufactured materials from Soviet Russia? Dictatorship—whether fascistic or communistic—is hard to reconcile with the political principles to which we in this country hold, but it has an undoubted effectiveness in accomplishing, even if at great cost, a specific objective. Russia is staking extravagantly on the Five-Year Plan, and the temper of her people is such as to make them willing to undergo serious privation to insure its success; and in this dramatic gamble of profits and losses and political economies are cast the minds and machines that such countries as the United States have sent to Stalin's aid.

Engineers, with the spirit that recognizes the technological rather than the political and sociological aspects of services it performs, have found abundant opportunity for professional practice in a country that is seeking rapidly to become an industrial power. There are differences of opinion as to whether or not these services should have been granted, and only the future will show which opinion is wisest. In the conflict of social and political ideals it would be blind folly to assume that the western hemisphere can learn nothing from the eastern. Although far apart in their traditions and cultures, the West and the East have been brought so closely together by man's ingenuity that each must heed the other. Strange indeed would it be if the millions who inhabit Russia, Siberia, China, and India should not be able to make some contribution to a civilization that, through the rapidly expanding means man has devised for communication, is bound to become more universal as time goes on. While it is natural to protect our own ideals and standards of living, of what permanent value are they, even for us, if they cannot withstand the concussion of those to which others owe allegiance? If by sending minds and machinery to Soviet Russia we have endangered our standards and ideals, it is well to know now that our civilization is so vulnerable and to seek those changes that shall strengthen it. Engineers who have so effectively altered the mode of living of western nations should be the last to complain of this form of competition. It should, rather, offer them a challenge, as present conditions do, to prove that their profession may benefit the entire world without the exploitation of some parts to the advantage of others.

"Selling Short"

THE device of "selling short" appears to be quite mysterious to the average man, and the majority seem to feel there is something wicked about it. In ordinary times selling short may be used to depress prices. Prices on exchanges, be it the Stock Exchange in Wall Street or the wheat pit in LaSalle Street, are, of course, regulated by the same law of supply and demand that governs prices throughout economic life. Selling short, i.e., selling goods such as securities or wheat or corn which the seller does not possess, appears to increase artificially the supply and in this way hold down the rising tendency of prices and under certain conditions create a downward tendency. There have been numerous attempts in the past to regulate or even prohibit entirely short selling, and many today feel that prices on the exchanges could be kept higher if in some way short selling were done away with.

There seems to be a good deal of misunderstanding of the working of economic machinery in the above view. There is an old Exchange saying that—"He who sells what isn't his'n, must buy it back or go to prison." It must not be forgotten that a man cannot sell what he does not have and collect the price of his sale. When a man sells short he has made only half of the trade. In addition to selling the goods he must deliver, and in order to deliver he must procure them from somewhere. Therefore a man who is selling short commits himself to become a buyer at some future time. What, then, is the economic value of short selling? It is obvious that a man who sells today with the expectation of repurchasing what he has sold at a later date, believes that prices will go lower. He may be right and he may be wrong. If he is wrong he will pay for his mistake, because he will have to buy at a higher cost than he sold. In this case the transaction carries its own punishment, and when the prices show an upward trend the so-called covering by short sales has a tendency to accelerate the rise.

What happens, however, if the short seller is right? If he is right, it means that at the time when he made his short sale conditions were such that the prices were due to go down. Every sale, whether a true sale or a short sale, by increasing the supply of stock or commodities, tends to depress prices. If, however, the conditions were favorable to a fall of prices, this would have occurred whether or not there were any short sales. The effect of the short sales in this case is to hasten the decline of prices and prevent a possible rise of prices on the eve of a subsequent decline. In this case the effect of short sales is decidedly beneficial. No one wants to see prices go down, but occasionally they have to, and when this happens it is better for all concerned that the prices drop from a lower level than from a higher one. When they drop from a higher level the disturbance is greater and there is more chance that some unfortunate buyers will get in the market on the long side at the high price and suffer in consequence when the drop comes. And when prices do begin to slide down it is of the greatest importance to have available persons who are willing to buy and capable of buying stocks or commodities. Suppose a certain stock goes down five points. If at this price some buying appears, the descent may be stayed. But if no buying appears, then the offerings of the stock will

cause a further decline, possibly fifteen, twenty, or more points. When a dangerous decline of prices takes place, and particularly when a panicky condition develops, comparatively few moneyed men are inclined to risk buying on the strength of their judgment that the prices will not go down further. Under these conditions it is vital to have some one who can afford to buy at the low prices developed, and who can make money by doing so. Here is where the economic value of short selling comes in. The short seller has to cover his sales by the purchase of the stock of which he is short, and the time when prices are low is just the period when he can do this. It is to his own greatest advantage, and incidentally to the advantage of the market as a whole. In doing this he does not take any chances, except the possibility of paper lack of gain, because the stocks might go down still further. Let us assume that a man sells Transamerican Steel short at $160 per share. Prices then crash and Transamerican is quoted at $140. The short seller buys and makes a profit of some $20 a share less expenses, but he takes off the market an offering of that particular stock and to that extent helps stay the decline of prices. In other words, short selling acts as a sort of a balance wheel opposing the excessive run-up of prices during bull periods, and providing means for preventing prices from tobogganing completely in times of falling prices and panics.

There is another aspect of short selling which, however, is applicable more to the case of commodities than to securities. Suppose that the River Grain Company has 2,000,000 bushels of wheat which it expects to deliver to the market in, say, 45 days. The prices today are good and acceptable to the seller, but he is, of course, entirely uncertain as to what they will be six weeks hence. He therefore effects what is technically known as a "hedge" by selling short his wheat on some one of the world's markets. The three principal markets for wheat are Chicago, Liverpool, and Winnipeg, with Chicago far in the lead of the other two. The River Grain Company sells 2,000,000 bushels of wheat short, meaning thereby that at the time of the sale it does not have the wheat in a form in which it can be delivered to the purchaser. The contract, however, provides that delivery shall be made within a certain time, say, 60 days, and the company expects to have the wheat by that time in a form that will make good delivery. Now, it is not at all necessary as a matter of fact that the wheat sold short in Chicago should be delivered in that market. It may be delivered in Liverpool or some other place and the deal straightened out by an exchange of certificates and clearances. Of course, it is also perfectly possible for John Smith to sell wheat short in Chicago without having any or expecting to have any actual wheat to deliver. In sixty days he will have to settle with the buyer, either by paying him a certain amount or collecting from him, depending on the course of prices, and the buyer, as a matter of fact, cannot know whether Smith is selling actual wheat which he does not have but expects to have, or whether he is merely speculating on a possible fall of prices. So long as the buyer is protected, however, and knows that he will get the wheat in some form, either actual or by certificate, he does not care, and he has the right to demand wheat if he wants it.

It is important to know that in a short sale of the "hedge" kind the seller is not interested in the future course of prices, because if prices go up he will lose on his short sale but will make up the loss from what he actually gets for his grain above the price of the short sale. If prices go down he does not care either, because the profits from the short sale will compensate for the lesser price obtained for the actual wheat. Here-therefore, the hedge short sale acts primarily as a price insurance, and not at all a device of speculation.

As regards the mechanism of the sale, there is an essential difference between short sales of stocks and short sales of commodities such as wheat. In a short sale of wheat the seller guarantees his performance but cannot be called to make delivery for a certain period of time, 30, 45, or 60 days, depending on the exchange and the commodity. In a short sale of stocks the seller must deliver the stock which he sold short the same day, or the next day, or the first future day of settlement, depending again on the rules of the exchange. However, as he has sold something which he does not have, he borrows stock from some one else and makes delivery with this borrowed stock, paying the owner of the stock for the privilege. This again imposes a certain natural restriction on the possible volume of short sales, because if too much stock is sold short, the supply available for borrowing purposes becomes exhausted and the lenders of stock begin to ask premiums which may rapidly mount to an extent that would prevent all possibility of making a profit on the short sale.

Daniel Guggenheim

THE interests and activities of Daniel Guggenheim, whose death, on September 28, was such a loss to the world, mark the man as one who successfully coordinated many and varied elements of life. The business enterprises which he and his brothers carried on so successfully made it possible for him to practice numerous and oftentimes anonymous philanthropies, and to become a patron of the arts and sciences in a way that testified to his sincere appreciation of cultural and humanitarian values. Bringing to aeronautics in the time of its great need the concrete evidence of his faith in its future that the donation of two and a half million dollars represented, he made it possible for worthy developments in this field to get their start under the auspices of the board of distinguished persons who administered the Daniel Guggenheim Fund for the Promotion of Aeronautics.

In the mining industry, in which the father, Meyer Guggenheim, became interested many years ago, the Brothers Guggenheim have been powerful and important figures. Adapting the methods of scientific research to the problem of extracting copper from unpromising ores, located in places making mining operation unusually difficult, these brothers, after sinking $50,000,000 in the Chile Copper Co., were rewarded by seeing their assets in this property mount to $200,000,000, and the process they adopted become one of the lowest cost methods of production the world has known.

Of world-wide interest recently has been the reorganization of the Chilean nitrate industry by the Brothers Guggenheim, in which once more an improved process has made possible radical reductions in production costs. The significance of this development to the economic position of Chile is hard to overestimate. The project is another demonstration of the courage with which Daniel Guggenheim and his brothers face problems involving great risks. It was characteristic of Daniel Guggenheim that he pinned his faith on modern methods in science, engineering, and business, and frequently found his success lying in the regions that these methods have added to the frontiers of man's knowledge.

Somewhat more than a year ago Daniel Guggenheim was presented the "Spirit of St. Louis" Medal, established by the citizens of St. Louis in 1929 to be awarded from time to time by The American Society of Mechanical Engineers "for meritorious service in the advancement of aeronautics." It is indeed fortunate that this award was made before Mr. Guggenheim's death, and that he lived to see the first fruits produced by the Fund for the Promotion of Aeronautics. The death of Mr. Guggenheim will be a great loss to many branches of engineering.

International Rules and Regulations for Acceptance Tests of Steam Turbines

INTERNATIONAL correspondence concerning the manufacture and sale of steam turbines will be greatly facilitated in the future. For the first time in the history of steam engineering a set of rules and regulations for acceptance tests of this prime mover has been developed and approved for use in international commerce by twenty-seven commercial nations.

This group of nations functioning through their national committees of the International Electrotechnical Commission, organized I.E.C. Advisory Committee No. 4 on Prime Movers in July, 1924. The engineers who were charged with the responsibilities of this undertaking were selected from the following ten member-countries: Canada, Czechoslovakia, France, Germany, Great Britain, Italy, Norway, Sweden, Switzerland, and the United States. The United States National Committee of the I.E.C. was assigned the duties of secretariat. It in turn requested Dr. Fred R. Low, editor emeritus of *Power*, to accept the directorship for this international committee.

The first meeting of this committee was held in New York in April, 1926, during the Plenary Meeting of the International Electrotechnical Commission. This meeting was short, but agreements were reached on several important technical points. The second meeting was held in Bellagio, Lake Como, Italy, in September, 1927, at which good progress was made toward the development of what has become Part I, Specifications.

Following this meeting the I.E.C. limited the activities of Advisory Committee No. 4 to hydraulic turbines and appointed a new Advisory Committee No. 5 on Steam Turbines having the same member-countries. The first meeting of the newly constituted committee was held in The Hague, May, 1928. It was at this meeting that the code in its present form took definite shape. An outline was adopted which, though since modified, has served as a guide and a means by which the valuable material contained in the several national codes could be shaped to fit the requirements of an international document. In its final form the I.E.C. Publication on Steam Turbines consists of—

PART I

Specifications
Appendix A—Information to be supplied with inquiry or order for steam turbines
Appendix B—Suggested standard ratings of steam turbines
Appendix C—Suggested standard boiler steam pressures
Appendix D—Graphical symbols for steam-turbine-plant layouts.

PART II

Rules for Acceptance Tests:
Section 1—Object and scope
Section 2—Enumeration and description of terms, including letter symbols for heat and thermodynamics
Section 3—Guiding principles
Section 4—Mandatory rules for instruments and methods of measurement
Section 5—Computation of results
Section 6—Report of tests carried out in accordance with I.E.C. rules for acceptance tests.

All of the countries specially interested in this subject have given their best talent in the preparation of this code or set of rules and regulations. Their experienced engineers, drawn from the manufacturer and user groups, formed the several delegations at the meetings. Between meetings the numerous preliminary documents distributed by the secretariat and the national committees were generally circulated to the manufacturing and using interests in each country for criticism and comment.

While the work of Advisory Committee No. 5 has been conducted along the broadest lines, certain personalities stand out prominently. Francis Hodgkinson, Consulting Engineer, Westinghouse Electric and Manufacturing Company, Philadelphia, Pa., represented Dr. Low and the U. S. National Committee at the meetings in Bellagio, The Hague, London, and Stockholm, and has been untiring in his efforts to assist the national and international committees in formulating their opinions on the many issues involved in the development of this international publication.

Great Britain's delegations included Frederick Samuelson, Chief Mechanical Engineer, British Thomson-Houston Company, Ltd., Rugby; Henry L. Guy, Chief Engineer, Mechanical Engineering Department, Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester; William H. Patchell, Consulting Engineer, 64 Victoria Street, Westminster, London; Isaac V. Robinson, British Electrical and Allied Manufacturers' Association, 36 Kingsway, London; Bedrich Pochobradsky, Chief Engineer, General Electric Company, Ltd., Erith, Kent; and Dr. George Gerald Stoney, F.R.S., formerly Consulting Engineer, C. A. Parsons and Company, Ltd., Newcastle-on-Tyne. In addition to these Messrs. Maurice G. S. Swallow, T. Roles, John P. Chittenden, Robert Dowson, and Arthur Nichols Moore attended certain of the meetings.

The United States delegation at The Hague and London meetings consisted of Messrs. Francis Hodgkinson and Irving E. Moultrop, Chief Engineer, The Edison Electric Illuminating Company of Boston, Boston, Mass. At the Stockholm meeting, however, the following important additions were made to this group: William L. Abbott, Chief Operating Engineer, Commonwealth Edison Company, Chicago, Ill., Geo. A. Orrok, Consulting Engineer, New York, N. Y.; Dr. Harvey N. Davis, President, Stevens Institute of Technology, Hoboken, N. J.; Ely C. Hutchinson, Editor, *Power*, McGraw-Hill Publishing Company, New York, N. Y.; and Prof. Joseph H. Keenan, Assistant Professor of Mechanical Engineering, Stevens Institute of Technology, Hoboken, N. J.

The French National Committee sent to the meetings Georges Darrieus, Engineer, Cie. Électromécanique, Paris; Louis Cauchois, Chief Engineer, Association Propriétaires de Machines a Vapeur, Rouen; and Alfred Risler, Chief Engineer, Société Alsacienne de Construction Mécanique, Belfort.

Germany's representatives at most of the meetings were Prof. Emil Jossé, Technical High School, Charlottenburg; Prof. Dr. Ernest A. Kraft, Technical High School, Berlin, and Director, Allgemeine Elektrizitäts-Gesellschaft, Berlin; and Philipp Reuter, Director, Rheinisch-Westfälisches Elektrizitätswerk, Essen. Karl Henkey, Chief Engineer, I. G. Farbenindustrie, Cologne, attended the Stockholm meeting.

The Swiss delegates were Adolphe Meyer, Director, Brown-Boveri & Company, Ltd., Baden; and Dr. Jean de Freudenreich, Chief Engineer, Brown-Boveri & Company, Ltd., Baden.

Sweden sent Vilhelm Nordstrom, The De Laval Steam Turbine Co., Stockholm; A. Lysholm, Chief Engineer, Ljungström Steam Turbine Co., Stockholm; Manne T. Lindhagen, Managing Director, Ljungström Steam Turbine Co., Stockholm; O. Wiberg, Chief Engineer, Svenska Turbinfabriks Aktiebolaget Ljungström, Finspong, and Einar Pyk, Engineer, S.T.A.L., Finspong.

Italy was represented by Prof. Anastasio Anastasi, Royal School of Engineering, Rome; and by A. Dalla Verde, Director, Centrale della Società Idroelettrica Piemonte, Turin; and Belgium, though not a member-country, was represented by Baron E. Forgeur Director General, Association des Centrales Électriques Industrielles de Belgique, Brussels; and Justin Raskin, Ingénieur et Chef Directeur, Service de l'Éléctricité de la Province d'Anvers, Curnhout. Holland also had a part

DELEGATES TO THE STOCKHOLM MEETING OF THE I.E.C. ADVISORY COMMITTEE NO. 5 ON STEAM TURBINES AND THEIR SECRETARIAL ASSISTANTS

(1) A. Meyer, (2) F. Hodgkinson, (3) E. Jossé, (4) F. Samuelson, (5) A. Anastasi, (6) L. Cauchois, (7) O. Wiberg, (8) Mlle. M. Gillet, (9) D. M. Radovanovitch, (10) H. L. Guy, (11) E. A. Kraft, (12) B. Pochobradsky, (13) I. V. Robinson, (14) O. Mastovsky, (15) M. T. Lindhagen, (16) M. Rubeska, (17) C. B. LePage, (18) Miss J. M. Meyer, (19) Miss G. Andrén, (20) I. E. Moultrop, (21) E. C. Hutchinson, (22) E. Forgeur, (23) J. H. Keenan, (24) W. L. Abbott, (25) G. G. Stoney, (26) A. Risler, (27) J. de Freudenreich, (28) T. K. A. Nordensson, (29) R. Dowson, (30) E. Pyk, (31) J. P. Chittenden, (32) A. Nichols Moore

in this work. It entertained the committee for its 1927 meeting and selected Prof. Clarence Feldmann, Technical University, Delft, and past-president of the International Electrotechnical Commission, to preside at that meeting.

During the development of this I.E.C. publication, Advisory Committee No. 5 made frequent reference to and appropriated some of the material contained in the publications issued by the engineering societies of several of the member-countries. These publications are: "Regeln für Abnahmeversuche an Dampfanlagen," prepared by a German Committee and published in 1925 by the Verein Deutscher Ingenieure; "Regeln für Lieferung und Abnahmeprüfung von Dampfturbinen," prepared by a Czechoslovakian Committee and published in 1925 by the Ceskoslovenska Normalisacni Spolecnost; the "Report on Tabulating the Results of Heat-Engine Trials," prepared by a British Joint Committee and published in 1927 by the Institution of Civil Engineers; and a "Test Code for Steam Turbines," published in 1915 and 1928 by The American Society of Mechanical Engineers.

A brief review of this activity gives convincing evidence that this I.E.C. publication on steam turbines has been prepared by the world's experts in the field of the manufacture and testing of steam-turbine installations. The results of their efforts are intended for use primarily in international trade. They will no doubt serve also to unify the several provisions of the various national codes on this same subject.

It will be recalled that the International Electrotechnical Commission includes in its membership national committees in twenty-eight countries from all parts of the globe.

The U. S. National Committee of the I.E.C. is made up of representatives of the American Institute of Electrical Engineers, National Electric Light Association, National Electrical Manufacturers Association, the American Society for Testing Materials and The American Society of Mechanical Engineers.

The American Society of Mechanical Engineers through the activity of its Main Committee on Power Test Codes has been chiefly interested in assisting to bring about international agreements on acceptance tests for prime movers.

International Congress of Applied Mechanics at Stockholm[1]

THE International Congress of Applied Mechanics at Stockholm held its sessions from the 24th to the 29th of August, last. This was the third Congress of the kind, the first being held in Delft, Holland, in 1924, and the second in Zurich in 1926, and was a great success. More than four hundred members attended the meetings, and more than thirty countries were represented. One hundred and fifty papers were presented, of which about thirty per cent were in the English language.

As compared with the previous gatherings, there was a larger representation of industry at this Congress, more than fifty delegates from industrial concerns taking part in the work. This affected to a certain extent the character of the papers presented and the direction of the discussions. There is no doubt that in the future international congresses of mechanics will be places for the exchange of opinions and the discussion of problems not only for university professors but also for representatives of industrial-research laboratories and for designers in the new fields of engineering in which research and preliminary theoretical investigations are of such vital importance. In such a form these congresses are playing a very important rôle in bringing in close contact for mutual discussion the representatives of science and the men from industry.

It is to be noted that the United States took a more active part in the Stockholm Congress. While only five Americans attended the Congress at Zurich, this year thirty-five members of the Congress were from America and nineteen papers were presented, the majority of which were prepared by representatives of American industry.

For presentation and discussion the papers of the Congress were subdivided into the following four sections:

1 Hydrodynamics and Aerodynamics
2 Theory of Elasticity, Plasticity, and Strength of Materials
3 Stability and Problems of Vibration
4 Problems of Ballistic and Rational Mechanics.

The languages at the Congress were English, French, German, and Italian.

Although the members of the Congress were not restricted in their choice of subjects for papers, it was decided to devote the discussions principally to a thorough treatment of a few subjects of major importance; namely,

Section I. (*a*) The theory of propulsion
(*b*) The problem of resistance.
Section II. (*a*) The limit of rupture
(*b*) The theory of plasticity.
Section III. (*a*) Stability and strength of thin-walled constructions
(*b*) Oscillations of ships and vehicles
(*c*) Acoustics of halls.

The intention was to get these questions elucidated by means of the delivery of general lectures, and the following were accordingly given:

Section I: (*a*) "Das Turbulenzproblem," by C. W. Oseen, Professor at the University of Upsala, Sweden
(*b*) "Das Widerstandsproblem," by F. Eisner, Professor at the Polytechnic Institute, Berlin
(*c*) "Airscrew Theory," by Prof. L. Bairstow, England.
Section II: "Ueber die bisherigen Ansätze in der Klassischen Mechanik der Kontinue," by R. Mises, Professor at Berlin University.
Section III: (*a*) "Strength and Stability of Thin-Walled Constructions," by S. Timoshenko, Professor at the University of Michigan, U. S. A.
(*b*) "L'oscillation des véhicules," by M. Panetti, Professor, Scuola di Ingegneria, Turin, Italy
(*c*) "Raumakustik," by E. Michel, Professor at the Polytechnic Institute, Hanover, Germany.

All these lectures were succeeded by discussions and by papers presented in each of the sections.

The applications of aerodynamics in such new fields as airplane and airship construction continue to attract the interest of mathematicians and engineers, and the discussions in Section I, which dealt with these subjects, were very lively.

The theoretical papers in Section II were concerned principally with the application of stress analysis to various engineering structures. The experimental papers in the same section dealt principally with fatigue of metals and with internal friction.

In Section III such problems as the buckling of thin plates under compression, and shearing stresses and buckling of corrugated metal sheets, were discussed in detail; also the analysis of stresses in plates submitted simultaneously to bending and compression or tension such as the plates of a ship's hull. A considerable number of problems on the investigation of vibrations were also discussed in this section.

Section IV dealt principally with problems of a more theoretical character, and a goodly number of mathematicians took part in this section.

Arrangements for succeeding congresses were discussed at Stockholm, and it was decided that the Congress of 1934 will be held at Cambridge, England, and that of 1938 in the United States.

These congresses have proved very useful in organizing exchange of opinions in various branches of applied mechanics and in bringing together men of science and men of industry. It is to be hoped that in the future American engineers will take a more active part in these congresses. Eight years from now we shall have to show what we have done in mechanics.

While the above sessions were going on, the ladies were entertained by motor trips and visits to the points of interest in Stockholm and its neighborhood. The attractions were sufficient to bring even some of the members away from their meetings. The first of the real social events of the official program, however, was the reception at the Swedish Academy of the Engineering Sciences on the evening preceding the opening of the congress. Here members and their guests were welcomed informally and given the opportunity to meet old acquaintances or make new ones.

On the first evening of the Congress, the City of Stockholm arranged a banquet and ball at the City Hall. An adequate description of the splendor of this building, the warmth of the hospitality, the very perfection of the event, would demand literary training beyond that of a scientist. It is well that the proceedings make no attempt to cover this side of the program.

On the second evening from the above, a subscription dinner and dance were held at the leading hotel of Stockholm. This was a smaller affair than the preceding, but a gay one. It might be mentioned that although there were four official languages for the scientific part of the program, there was essentially only one on the dance floor and that made in America.

On the closing day of the Congress there was a boat trip among the beautiful islands which crowd the waterways of Stockholm to Saltsjobaden, where the Banquet of the Congress took place.

[1] Prepared from reports submitted by S. Timoshenko, Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich., Mem. A.S.M.E., Chairman of Special Congress Committee of A.S.M.E. Applied Mechanics Division, and Wendell M. Coates, Instructor in Engineering Mathematics, University of Michigan, Ann Arbor, Mich.

Metal Week in Chicago

DURING the week of September 22 to 26 visitors at Stevens Hotel, Chicago, had an opportunity to obtain a bird's-eye view of the state of steel metallurgy in the United States at the present time. In addition to the Twelfth National Metal Exposition, five societies prominent in the metallurgical field held their meetings, namely, The American Society of Mechanical Engineers, the American Society for Steel Treating, the Institute of Metals and the Iron and Steel Divisions of the American Institute of Mining and Metallurgical Engineers, and the American Welding Society.

Along with the papers presented during the week, the exposition showed the main trends of interest in the steel industry of today, barring, however, the heavier portions, such as open-hearth and rolling-mill activities. From these it would appear that the two features attracting the greatest attention of the industry today are alloy steels and welding. From the point of view of the user, which is that of preeminent interest to mechanical engineers, this is only natural and merely signifies that both alloy steels and welding have practically passed the experimental stage.

Alloy Steels

In the field of alloy steels, some alloys resistant to high temperature were shown. None, however, exhibited any particular novelty of composition or treatment. Some interesting alloy castings, however, were shown, which indicates that they are already generally available to the user. One such casting was a screw conveyor made in one piece.

On the other hand, rust- and corrosion-resistant alloys were shown by a number of companies. Most of these were of the so-called 18-8 type, or the Krupp austenitic structure. Just how rapid the development of this kind of an alloy has been is indicated by the fact that the tonnage alone now used by the Ford Motors Company is practically equal to the total tonnage produced in the whole of the United States only a year ago. The compositions of the rust-resistant alloys do not vary much between the various producers, most of whom, for that matter, are licensed under the Krupp patents. They have all developed methods of their own for handling and polishing the material, and while not all varieties of the polishing machinery were shown, it is known that a number of difficult mechanical questions had to be solved to produce a uniform high-grade finish in both sheets and rods, and that considerable ingenuity was displayed in the designing of this machinery.

Nitriding—which means case-hardening by gases containing nitrogen—of steel of a special composition containing aluminum was also widely exploited at the exposition. Machinery for producing nitrided parts, both in the way of furnaces for making the steel and special nitriding furnaces for producing the case, have been developed to the point where a very large production has become possible, and the cost of the material is not excessive. Little of this, however, was actually shown at the exposition.

Welding Progress

The other dominant feature of interest at the show was welding. Only a few years ago welding was looked upon as a means of making joints which were not supposed to be subjected to dangerous stresses, and the failure of which would not involve fatal consequences to life and limb. The attitude toward welding then was not only highly critical but in some quarters quite unfriendly. But the art kept on improving and a large variety of welding methods, particularly electric, were developed, such as the arc method, the quasi-arc, and the many forms of resistance welding. Not only that but there have been rapid advances in such welding supplies as welding rod, fluxes, etc. As the art developed, greater confidence was reposed in it, while the cost of operation decreased partly through the introduction of more dependable machinery—among others, automatic welding machinery—and partly because of better understanding and standardization of methods of operation which reduced the number of failures and simplified the matter of inspection.

The stage has been finally reached where, as in the manufacture of electrically welded pipe, the weld may be assumed to be as strong as the base metal and to be capable of withstanding stresses which only a few years ago would have been considered unbelievable.

A number of methods of both acetylene and electric welding were exhibited at the show. In the acetylene field the greatest progress in the last year or so has been made in cutting metal to given shapes by acetylene torches, and, for example, machines were shown for rapid-production shape cutting (Camograph) and for straight- and curved-line cutting (Radiograph).

In the field of electric welding the General Electric Company showed several types of atomic-hydrogen welders both hand-operated and automatic, and also an ammonia dissociator, the purpose of which is to provide a source of hydrogen from ammonia that will be more easily accessible than pure hydrogen. The Haynes Stellite Company, in addition to a process of deposition of stellite welding rod on wearing parts of machinery to prolong their life, showed a material said to be cast tungsten carbide which was remarkable for its hardness. An "Electronic Tornado" welder for carbon-arc welding was shown in action by the Lincoln Electric Company, which also exhibited a motor capable of operating under water. The Stoody Company exhibited welded-on overlays made from alloy welding rods, by means of which an extremely hard surface can be produced on comparatively mild steel. The process is substantially the same as that used by the Haynes Stellite Company, with the difference that while the Haynes Company uses primarily an alloy of chromium and cobalt for the hard surface, the Stoody Company resorts to a material with a tungsten carbide base.

Butt-welding and spot-welding machines of several types were shown by the Taylor-Winfield Corporation and the Thomson-Gibb Electric Welding Company. The Una Welding & Bonding Company showed several types of arc-welding machines, both semi-automatic and automatic, while a wide variety of machines was shown by the Westinghouse Electric & Manufacturing Company. In this connection attention may be called to a paper presented before the Welding Society during the week by T. R. Watts, of the Westinghouse Company, describing a non-destructive method of magnetically testing butt welds. The value of this paper lies in the fact that even in automatic welding each weld stands by itself, and only when reliable methods of non-destructive testing have been developed will it become possible to use welds with absolute certainty as to their strength and reliability.

Machinery and devices for polishing and grinding were much in evidence at the show. One of the reasons why polishing attracted particular attention was that the non-rusting steels, which are now being so extensively used, either have to be polished in order to show to the full extent their non-rusting properties, or are materially improved in looks by polishing.

A device exhibited which is not much known in this country was the Thiel precision die-sawing and filing machine; this, it is claimed, will cut everything in the metal line from aluminum to high-speed tool steel.

Book Reviews and Library Notes

THE Library is a cooperative activity of the A.S.C.E., the A.I.M.E., the A.S.M.E., and the A.I.E.E. It is administered by the Engineering Foundation, Inc., as a public reference library of engineering and the allied sciences. It contains 150,000 volumes and pamphlets and receives currently most of the important periodicals in its field. It is housed in the Engineering Societies Building, 29 West 39th St., New York, N. Y. In order to place its resources at the disposal of those unable to visit it in person, the Library is prepared to furnish lists of references on engineering subjects, copies of translations of articles, and similar assistance. Charges sufficient to cover the cost of this work are made.

The Library maintains a collection of modern technical books which may be rented by members residing in North America. A rental of five cents a day, plus transportation, is charged. In asking for information, letters should be made as definite as possible, so that the investigator may understand clearly what is desired.

Principles of Engineering Economy

PRINCIPLES OF ENGINEERING ECONOMY. By Eugene L. Grant. The Ronald Press Company, New York, N. Y., 1930. Cloth, 5¾ × 8¼ in., 387 pp., 12 charts, $3.75.

REVIEWED BY WILLIAM D. ENNIS[1]

THIS is not a book on "industrial engineering." It belongs to the school of Fish's "Engineering Economics" (1915). It is not intended especially for the factory manager, but for the designing and administrative engineer in any field: and would also be good reading for those who are responsible for the financing of industrial and engineering projects.

Professor Grant's central thought is that the dollar sign is a factor in every engineering problem. Rather unexpectedly, perhaps, the illustrative problems are drawn largely from the fields of civil and electrical engineering. They are good problems, based on real data. The author has set himself the ambitious task of discovering and developing the fundamental principles—if any—underlying the business side of engineering. They are, of course, merely the fundamental principles of business itself: "Economy is getting the most for your money..... The central problem.....is.....whether any proposed course of action.....will prove to be economical in the long run."

Prominent among fundamental principles recognized by Grant is the "load factor" principle. He sees its application in many fields beyond the central station. He grasps the significance, in any economic activity, of "capital turnover," the ratio of annual sales to investment. He recognizes the importance of "judgment factors" in several of his chapters, and tries to avoid that deceptive rigor which characterizes the bulk of undergraduate computation.

This book altogether avoids traditional economics and deals only lightly with formal accounting and cost accounting. There is a brief but broad treatment of depreciation in connection with which there is reference to the problems involved in valuation, and to the necessary differences between ordinary valuation and the establishment of a public-utility rate base. One is left with the impression that the author might have done well to expand his meager reference to the subject of public-utility rates.

Similarly the treatment of financing problems per se might well have been extended. There is a bare remark characterizing the difference between sinking-fund and serial bonds, but important associated topics are ignored: such as the advantages and complications of the pay-as-you-go plan, especially for recurring expenditures in municipal administration, a subject recently and elaborately treated by Studensky.

The chapter on statistical methods, while well documented, fails to be stimulating. The average reader would have to "bolt" much of the material on errors in sampling. The topic of correlation is made needlessly difficult.

The best thing in the book is its emphasis on what may be called the time factor in money values. The dollar of today is worth more than the dollar of tomorrow. A proper recognition of the difference is rarely encountered in engineering calculations. Such recognition is necessary whenever projects of different initial costs, estimated lives, and operating expenses or revenues are compared. Planned and tested (at Montana State College and Stanford University) as a college textbook, this volume will have real value also to practicing engineers in many fields. It is a useful book.

[1] Alexander Crombie Humphreys Professor of Economics of Engineering, Stevens Institute of Technology, Hoboken, N. J. Mem. A.S.M.E.

Standard Costs

STANDARD COSTS: INSTALLATION, OPERATION AND USE. By G. Charter Harrison. The Ronald Press Company, New York, N. Y., 1930. Cloth, 5¾ × 8¾ in., charts and tables, $5.

REVIEWED BY J. W. FORESMAN[2]

WHEN Management becomes convinced that a cost system is as essential to its welfare as is a finance policy, a sales policy, a plant layout, or plant equipment, and installs an accurate cost system, it also comes into possession of an analysis that enables it to—

1 Eliminate unprofitable product
2 By study of detail, sometimes, transform unprofitable product into profitable product; and
3 Check profitable product from time to time in order that it may remain profitable.

All "cost systems" are in reality cost analyses; and any cost system that fails to furnish sufficiently detailed analyses to enable Management to encompass the aims enumerated above is faulty and inadequate to the needs of modern business. Mr. Harrison's work attempts, and attempts successfully, to set up a system of "yardstick measurements" that make quick analysis of period performances easily possible.

To what extent of detail any formal system can be applied to any particular manufacturing plant, without specific adaptation

[2] Lycoming Manufacturing Company, Williamsport, Pa. Assoc. Mem. A.S.M.E.

or alteration of detail, is possibly a moot point. But Mr. Harrison's principles and formulas are in basis so little open to dispute and so capable of expansion that it would be difficult to name another book of equal value to a manufacturing plant about to install a cost system of accounts. The minor variations necessary to adapt it to local conditions can offer few difficulties to any competent accountant.

It might be added that the author's efforts to impress firmly on Management's mind the fact that a cost system is a fine machine, as essential to a business as is its plant or equipment, is more than commendable; for without such a system the rocks yawn for commercial craft. And to this insistence on the necessity of an adequate cost system, Mr. Harrison, through the skilful yet simple way in which he has outlined its detail, has relieved those who would install one of the years of tedious study and labor that would be necessary did they attempt to work out their own salvation. To work from a manual is a simple thing; to attempt to create a structure out of one's own difficulties is another story altogether.

Ingenious Mechanisms for Designers and Inventors

INGENIOUS MECHANISMS FOR DESIGNERS AND INVENTORS. Edited by Franklin D. Jones. The Industrial Press, New York, N. Y., 1930. Fabrikoid, 6 × 9 in., 536 pp., illus., $5.

REVIEWED BY H. W. MILLER[3]

IT IS NOT often that one is privileged to review so excellent a piece of work as this recently issued book. Its purpose is to place before designers of not only so-called automatic machines but of almost any type of machine which employs any automatic features, the most ingenious, efficient, and practical combinations that have already been devised and tried out for the accomplishment of the multitude of individual functions which various parts of machines are called upon to perform. The editor says very pertinently in his preface that the present-day designer is confronted with two equally important problems in designing his machinery. The first, of course, is to design a mechanism that will function properly, meaning correctly and efficiently; and the second, to design with an eye to the cost of manufacture.

It has become more than merely desirable for us to have before us the approved precedents in the designing of machinery in this day of sharp competition, rising costs of materials and labor, and apparent decreasing supply of skilled artists and artizans. In a survey of the history of the development of automatic machines and inventions, we should probably have to classify the first devices employing the power of the wind or falling water to raise water for irrigation purposes as automatic machines. Such inventions are thousands of years old. Relatively little progress was made, however, in the devising of what we now call automatic machines until the steam engine had been so perfected as to make power available wherever it was desired. People remained hostile to so-called labor-saving devices until relatively recent years. In 1830 a sewing machine was patented in France by a man bearing the name of Thimonnair, and eighty of these were in use in 1841 for sewing army uniforms. However, they were destroyed by a mob, incensed over the fact that they were being deprived of their employment as army tailors.

In 1837 Charles Goodyear was granted patent No. 240 on his earliest process of curing rubber. In 1846 Elias Howe was granted patent No. 4750 on his epoch-making sewing machine. In 1863 over 38,000 patents had already been granted. In 1886 the number had risen to 350,000, in 1895 it reached 540,000, and only recently patent No. 1,760,000 was granted. The fact is too apparent to warrant discussion that the present advanced state of civilization in America as to conveniences, opportunities, education, and comfort is dependent largely upon our vast production made possible through the use of labor-saving devices, which means largely automatic or semi-automatic machines. The rapidly increasing rate at which inventors have secured protection for their devices or ideas and the direct effect of the application of these devices and ideas in the development of this vast country, physically, financially, and intellectually, make it plain that it is more than merely desirable to present in orderly fashion the most efficient and ingenious devices that have been contributing to this progress.

The material in this book is admirably presented, every device being clearly illustrated and fully described. Perhaps an engineer can be pardoned for saying that such a book provides most interesting reading to the end of its five hundred pages. This is actually true, because there is something in the nature of a romance associated with almost every mechanism. Each represents a clever solution of a different problem with, as the editor has pointed out in the beginning, an eye not only to the efficiency of the performance of the function but with equal thought to the cost of manufacture of the device.

The book comprises twenty chapters, each dealing with a different classification of mechanism or of function. These include cams and their applications, intermittent motions as obtained from ratchet gearing and from gears and cams, tripping or stop mechanisms, electric tripping mechanisms, reversing mechanisms, overload relief mechanisms, interlocking devices, reciprocating mechanisms, quick-return motions, speed-changing mechanisms, differential motions, straight-line motions, hydraulic transmissions, feeding mechanisms, and miscellaneous movements. The volume is well indexed so that the user may at once find the devices in which he is particularly interested, but the material is all so clearly and admirably presented that any designer securing the volume is almost certain to find it so interesting and to the point that he will make a complete survey of it. The book is heartily recommended to designers in general and to inventors in particular.

[3] Professor of Mechanism and Engineering Drawing, University of Michigan, Ann Arbor, Mich. Mem. A.S.M.E.

Books Received in the Library

BEITRAG ZUR FRAGE DER ERMITTELUNG DER MECHANISCHEN VERLUSTE BEI SCHACHTFORDERANLAGEN. By Albert Bierling. (Forschungsarbeiten, no. 328.) V.D.I. Verlag, Berlin, 1930. Paper, 9 × 12 in., 35 pp., illus., diagrams, tables, 6 r.m.

Reviews the methods that have been used to determine the mechanical losses in mine hoists and compares their accuracy. Two new methods applicable to hoists driven by three-phase induction motors are then developed, and the results obtained with them at German mines are given. The use of the methods is described in detail.

DIESEL ENGINE OPERATION, MAINTENANCE AND REPAIR. By Charles H. Bushnell. John Wiley & Sons, New York, 1930. Cloth, 6 × 9 in., 285 pp., illus., diagrams, tables, $3.50.

A clearly written, concise discussion from the point of view of the operating engineer. Fundamental principles are emphasized and much practical information and advice given.

DIE ELEKTRISCHE KRAFTÜBERTRAGUNG, vol. 1; Die Motoren, Umformer und Transformatoren. By Herbert Kyser. Third edition. Julius Springer, Berlin, 1930. Cloth, 6 × 9 in., 544 pp., illus., plates, diagrams, 36 r.m.

Beginning with the equipment for utilizing electric energy, this treatise treats of the whole field of transmission, transforming, converting, line construction, and power plants. The

present volume is devoted to motors, converters, and transformers. The characteristics of these machines, their connections, their uses, and their types are described quite in detail, with methods for comparing efficiencies. The work is non-mathematical and practical, theoretical matter being used only where necessary to explain practical points.

Engineering Kinematics. By William Griswold Smith. Second edition. McGraw-Hill Book Co., New York, 1930. Cloth, 6 × 9 in., 343 pp., illus., diagrams, tables, $3.50.

The fundamental laws governing the conversion and transfer of motion, and the ways in which these principles are applied to the design of machines, are here presented, with as much emphasis upon practical applications as the limits of a textbook permit. Many problems are given. The new edition is partly rewritten and brought up to date.

Forschung und Technik; Im Auftrage der Allgemeinen Elektrizitäts-Gesellschaft. Edited by W. Peterson. Julius Springer, Berlin, 1930. Bound, 9 × 12 in., 576 pp., illus., 40 r.m.

This book gives an insight into the scientific research that is being carried on in research institutes and by large industrial organizations. Specifically, it contains some forty papers upon present problems in various branches of physics, electrical engineering, machine design, and transportation, based on recent work of the Allgemeine Elektrizitäts-Gesellschaft, Berlin, and written by members of its research staff. The contents of the book cover a wide range and illustrate clearly the advantages to industry of systematic scientific research.

Gefällvermehrung bei Niederdruck-Wasserkraftanlagen. By Rudolf Gelbert. (Mitteilungen aus dem Gebiete des Wasserbaues und der Baugrundforschung, heft 2.) Wilhelm Ernst & Sohn, Berlin, 1930. Paper, 7 × 11 in., 22 pp., illus., diagrams, tables, 3.60 r.m.

Presents the results of tests of a method of increasing the head of low-pressure hydraulic turbines proposed by Dr. John R. Freeman. This method consists in introducing part of the surplus water, escaping over the dam, into the draft tube of the turbine, where it reduces the discharge pressure and thus increases the effective head.

Grundlagen und Entwicklung der Energiewirtschaft Österreichs. By Oskar Vas. Julius Springer, Wien, 1930. Paper, 8 × 11 in., 189 pp., illus., map, tables, 20 r.m.

A comprehensive report on the power resources of Austria and their organization, prepared for the World Power Conference at Berlin. The development of the fuels, water powers, and electricity is covered in full, the power organization of the railroad system is described, and the laws relating to water and electricity are given. A map shows coal mines and power plants.

Increasing the Recovery of Petroleum. By Wentworth H. Osgood. McGraw-Hill Book Co., New York, 1930. 2 vol., cloth, 6 × 9 in., illus., diagrams, tables, $10.

A compact summary of the information available on methods for increasing the recovery of petroleum from known fields. Existing conditions are discussed briefly, with the nature of reservoirs, the fluids involved, and the theory of normal production. The major part of the work is then devoted to an exposition of the hydraulics of oil-well flow, the thermodynamics of oil wells, and to a description of practical methods for increasing recovery and their success in various fields.

Der Industrielle Wärmeübergang. By Alfred Schack. Verlag Stahleisen, Düsseldorf, 1929. Cloth, 6 × 8 in., 411 pp., 18.50 r.m.

A practical textbook for engineers, based upon the investigations of the Verein deutscher Eisenhüttenleute. Radiation, convection, and conduction are discussed at length, the calculation of recuperators and regenerators is explained and the use of the theory of heat transmission illustrated by numerous practical examples. Throughout the work an effort is made to develop simple formulas that can be applied readily to practical problems.

Kraftwerks-Bauten. Siemens-Schuckert, Berlin, 1929. Paper, 8 × 12 in., 137 pp., plates.

A portfolio of photographs and plans of a number of electric power plants recently built by the Siemens-Schuckert works. The layout and construction of the buildings is considered, not the equipment. Brief data about capacity and equipment are given, with references to more comprehensive published description.

Life Expectancy of Physical Property, Based on Mortality Laws. By Edwin B. Kurtz. Ronald Press Co., New York, 1930. Cloth, 6 × 9 in., 205 pp., tables, $6.

The author applies the principles and methods used by life-insurance actuaries to the life problems of structures, machinery, equipment, and other physical property. Proceeding from a group of mortality tables collected during fourteen years of search, the author has brought together the mathematics that must be used, the data that are now available, and the procedure to be used in developing and applying mortality tables in specific cases.

Luftfahrtforschung. Vol. 7, No. 1–3 and Vol. 8, No. 1. Berichte der Deutschen Versuchsanstalt für Luftfahrt, Berlin-Adlershof, der Aerodynamischen Versuchsanstalt zu Göttingen, des Aerodynamischen Institutes der Techn. Hochschule Aachen. R. Oldenbourg, Munich, 1930. Paper, 8 × 11 in., 4 pts., illus., diagrams, Vol. 7, No. 1, 15 r.m.; No. 2, 13.20 r.m.; No. 3, 3.30 r.m.; Vol. 8, No. 1, 7.80 r.m.

The first of these reports, by Wilhelm Pleines, is an exhaustive report on the processes of riveting used in German aircraft factories and the machines used. The strength of riveted duralumin joints is also discussed, on the basis of laboratory tests. The second report, by Martin Abraham, is devoted to wire and wire rope for airplanes. Other reports discuss the resonant vibration of propellers, buckling tests on thinly covered rods, and tests of short bolts in wood.

Material Control and Storeskeeping in Machine Shops and Foundries. By Willis Wissler. Ohio State University Press, Columbus, 1929. (Special Bulletin of the Bureau of Business Research, College of Commerce and Administration, O.S.U.) Boards, 9 × 11 in., 284 pp., forms, $2.50. Residents of Ohio, $1.50.

This study of methods of material control and storeskeeping gives a record of practice in nine Ohio machine shops and foundries, with some generalizations drawn from a comparison of their methods. The study is descriptive, not analytic.

Mechanical Engineers' Handbook. Edited by Lionel S. Marks. Third edition. McGraw-Hill Book Co., New York, 1930. Fabrikoid, 5 × 7 in., 2264 pp., diagrams, tables, $7.

In preparing the new edition of this well-known work of reference, special attention has been paid to the increasing importance of a knowledge of the fundamental theory underlying the design and operation of machinery. Theoretical discussions have been strengthened and new sections added on such important subjects as vibration and dimensional analysis. Standards and practice have been brought up to date, and physical data have been revised. New sections have been added, making the book nearly three hundred pages longer. The new edition will be welcomed warmly by engineers.

Synopses of A.S.M.E. Transactions Papers

THE papers abstracted on this and following pages appear in the current issues of Aeronautical Engineering, Textile, and Wood Industries sections of A.S.M.E. Transactions. These sections have been sent to all who registered in the similarly named Divisions. Other sections are in the course of preparation and will be announced when completed, in later issues of "Mechanical Engineering."

AERONAUTICAL ENGINEERING PAPERS

A Study on Airplane Ceiling. By Louis Breguet and Maurice Roy. [Paper No. AER-52-8]

The useful torque exerted on the propeller shaft depends principally on the altitude, on the throttle setting, and on the r.p.m. of the engine. While the French Section Technique d'Aeronautique postulates that the variation of torque with altitude depends mainly on the density, the authors believe that, given good altitude adjustment and a carburetor heated to a constant temperature, the variation of torque depends directly on the relative pressure at altitude.

Having established formulas for power variation with altitude, it is possible to calculate the ceiling theoretically, provided the characteristics of the plane have been determined by tests in horizontal flight at any altitude and at any load whatsoever.

To obtain the greatest possible ceiling it is essential that:

1 The engine should turn at full throttle the greatest possible r.p.m.
2 The weight of the machine per horsepower at the ground should be as low as possible
3 The span loading should be as low as possible
4 The propeller should be designed to have maximum efficiency at the condition of minimum power.

With a specially designed plane and an unsupercharged engine the authors estimate than an altitude of 13,000 meters can be reached, beating previous records by some 2000 meters.

A few simple tests at one altitude with a careful record of all the elements involved can be made to give all the plans and propulsive group characteristics. The theory and practice of such experiments are fully developed in the paper.

Development of the Drop-Forged Metal Propeller. By Frank W. Caldwell. [Paper No. AER-52-9]

In this paper the author tells of various types of metal propellers for airplanes, and their advantages and disadvantages. These include a tubular type, a type built up of various structural members riveted or welded together, the plate type, and the drop-forged type which is the latest development. Hollow blades of aluminum alloy suitable for drop forging are used. The weight of these is slightly more than that of similar wooden propellers, and the limit of life has not yet been established.

Engineering Problems in the Operation of Air Transports. By Frank R. Canney. [Paper No. AER-52-10]

The author gives a masterly summing up of the hundred or more points that must be observed in the planning of a successful air-transport system, and reveals that there has been necessary only a slight modification of the original design of the Boeing transport plane as the result of the experience gained through its operation.

Aircraft-Float Design and Construction. By Holden C. Richardson. [Paper No. AER-52-11]

Designs of aircraft floats have included the canoe type, inflated bag or skid, box type, multi-rib type, canoe system with cloth over a thin, smooth skin, girder type, and all-metal construction. The author follows the development and discusses necessary characteristics. Late construction is principally of aluminum alloy for both floats and boats. Bulkheads are used to carry concentrated loads, and the bottoms are sometimes reinforced by exterior longitudinals. Extruded shapes, angles, channels, and tees are becoming popular as framing members.

Installation of Air-Cooled Radial Engines. By P. B. Taylor. [Paper No. AER-52-12]

This paper tells of some of the installation problems of air-cooled radial engines, and the author points out some improvements that are desirable. Engine exhaust and cowling systems are described, and the purposes of carburetor air heaters and cleaners are given. Variation of the viscosity of oil with temperature, together with its low heat conductivity, causes many difficulties in the lubricating system. Oil foaming is another source of concern to designers. An effective method of preventing this is to discharge the oil on a plate sloping into the oil volume and allow it to run down the sides into the oil tank.

There are many types of fuel systems, and the author gives some general considerations that should be followed in installation. To provide for inverted flight requires special arrangements to give satisfactory results.

All-Metal Airplane Construction. By Wellwood E. Beall. [Paper No. AER-52-13]

The loads to which airplanes are subjected are pretty well known, so the stresses in various members can be calculated. A light structure is necessary, but strength and durability must be increased due to the demand for greater speed and more hours in the air. Metal has thus been called into construction to help the designer.

Some of the advantages from use of metal in airplane construction include ease of determining the strength of members, decreased fire hazard, less danger to passengers in case of a crash, and decreases in cost of production, labor, handling, bulk, and waste.

Use of aluminum alloys is increasing, and monocoque construction is becoming more popular. Methods of analyzing the stresses in various members are given in the paper.

Service for Airplane Engines. By C. H. Biddlecombe. [Paper No. AER-52-14]

Properly equipped service stations with competent mechanics are being established at some of the principal airports to take care of airplane maintenance. These have been found necessary by airplane-engine manufacturers in order to protect both their own interest and those of the customer. The work varies from a simple engine overhaul to complete rebuilding of large aircraft, and includes such items as packing and loading large airplanes for export shipment; designing and building gliders; dismantling, trucking, and reassembling airplanes for aviation shows; demonstrating airplanes to customers, and many other details, but not including the making of new engines and airplanes.

It seems probable that the major overhaul stations will eventually function on lines similar to those of present wholesale jobbers in the automotive industry, with dealers doing all repair work, and buying necessary spare parts from jobbers in the territory in which they operate. Engine manufacturers look forward to having service representation at every active airport. The author tells of various methods and equipment used in overhaul work and the care necessary to insure satisfactory operation.

Silencing the Airplane. By H. L. Dryden. [Paper No. AER-52-15]

In this paper the author tells how sound is produced and defines intensity. Experiments and investigations made by the aeronautics branch of the Department of Commerce are described. These deal with the theory of engine mufflers and the soundproofing of airplane cabins. There appears to be no prospect that a device will be developed which at the cost of a pound or two of additional weight will eliminate the noise.

SOME CHARACTERISTICS OF LIGHT ALLOYS FOR AIRCRAFT. By H. W. Gillett. [Paper No. AER-52-16]

In this paper the author tells of the various light alloys that might be used to advantage in aircraft construction, and gives their advantages and drawbacks. As fast as the disadvantages are overcome, whether they relate to price, fabricability, or other properties, the improved material will find increased use in aircraft. Progress in aeronautics is linked closely with the metallurgy of light alloys.

SOME ECONOMICAL ASPECTS OF AIRPLANE DESIGN. By Schuyler Kleinhans. [Paper No. AER-52-17]

Airplane design requires a very clear idea of the duties to be performed. Specifications should include full information as to engine power, load, top speed, landing speed, climb, range of operation, restrictions of dimensions, special arrangements for dockng or storing, and factors of safety desired. The paper contains computations and graphs for planes with one, two, or three engines. It shows gains in pay load with reduction of top speed and increase in power loading. The three-engined plane suffers in comparison due to greater resistance from the greater division of power.

AIRPLANE SERVICING FROM THE OPERATOR'S POINT OF VIEW. By Richard C. Marshall. [Paper No. AER-52-18]

The necessity for periodic overhauls of equipment and the large financial outlay necessary to do this work properly form one of the operator's greatest problems. The author tells why centrally located shops equipped to do this work at lowest possible prices constitute the answer to the problem. This is an able and well-informed paper on airplane servicing, drawn from actual experience, and should be helpful to airplane operators.

VIBRATION CHARACTERISTICS OF AIRCRAFT-ENGINE CRANKSHAFTS. By Ford L. Prescott. [Paper No. AER-52-19]

Vibration troubles occurring in the rotating parts of machinery can be grouped in two distinct classes, (1) torsional and (2) flexural or whirling vibrations. In most types of machines the whirling vibration causes most grief, while the torsional type is comparatively unimportant. Exceptions to this are the gas and Diesel engines, where due to the great non-uniformity of torque the torsional vibrations are more important than the flexural.

The present state of the art of predicting by calculation the behavior of a machine in this respect is in quite different stages of development for the two types of vibration. As regards the determination of the frequency or the "critical speed," this can be done in the torsional case with an error of 5 per cent or less. In the flexural case, however, the frequency depends on the flexibility of the bearings and the frame, so that in a complicated machine errors of over 50 per cent are not uncommon.

The present paper gives a method of precalculating the frequency of torsional vibrations. The author reduces an engine with many cranks and pistons to a system with a single equivalent inertia in the center of the engine. Charts showing vibration records are included.

NEW DEVELOPMENTS IN AIRPORT LIGHTING. By H. C. Ritchie. [Paper No. AER-52-20]

The principles of airport lighting have been covered in many papers which have varied slightly and only in details, says the author, these principles now having been standardized through the medium of the Department of Commerce. These requirements are stated, and then the author points out some new developments which make it possible for airports to obtain maximum ratings for lighting equipment, and also some of the new systems or devices brought out to supplement these requirements.

AUTOMOTIVE METHODS AND PRACTICES INVOLVED IN AIRCRAFT ENGINES. By O. E. Szekely. [Paper No. AER-52-21]

The author draws a striking comparison between the cost of standard parts in automobile manufacturing and the cost of parts in airplane manufacturing. Iron and steel and other metals that enter in automobile manufacturing can be secured in the market at apparently a very much lower price than when it is known they are intended for use in airplanes. Although airplane making is a new industry, most of the principles involved in aircraft-engine manufacturing have long been practiced in the internal-combustion-engine industry.

METALLIZING THE AIRPLANE. By H. V. Thaden. [Paper No. AER-52-22]

At present there appears to be a gradual trend toward the use of metal in airplane construction. There are many design problems to be solved by research and experiment. Three basic materials or their alloys are now used in airplane construction. They are steel, aluminum, and magnesium. Extruded sections of duralumin can be formed readily and afford wide possibilities for moldings, trim, and primary structural members.

Internal cantilever wing bracing has developed to a point where it compares favorably in weight with externally braced structures. A smooth surface covering is most efficient, and rounding or filleting of corners and fairing the curves of the structure give high aerodynamic efficiency. The paper gives advantages and disadvantages of metal construction for airplanes.

SOME FUNDAMENTAL ECONOMICS OF AIRCRAFT OPERATION. By R. H. Upson. [Paper No. AER-52-23]

This paper is intended as a sequel to the author's paper entitled, "The Airship for Long-Haul Heavy-Traffic Service," presented at the annual meeting of The American Society of Mechanical Engineers in 1922. In that paper the airship was considered mainly as an ocean-going vessel, the principal comparison being made with ocean steamships. Various design problems were also discussed and the desirability of certain improvements pointed out. The situation needs reviewing on account of the sensational bid for transoceanic service that has since been made by the airplane and the fact that many of the improvements indicated as desirable in the previous paper have now been demonstrated in experimental form. Hence this paper is devoted principally to the consideration of the relative economic fields of airships and airplanes, the attempt being made to deal primarily with fundamental characteristics rather than with current performance records.

PRACTICAL AIRPLANE PERFORMANCE CALCULATIONS. By Dr. Michael Watter. [Paper No. AER-52-24]

A design must meet the characteristics set forth in the specification if it is to warrant construction. Performance characteristics represent a most important requirement, and there are today many methods and theories of performance calculation.

The conclusion was reached to obtain simplicity even at the cost of scientific accuracy, so long as the calculations gave a correct answer. The method described is based on the evaluation of parasite resistance, wing or cell characteristics, and knowledge of engine-propeller behavior. It is intended for routine calculations, but may be extended for special cases.

TEXTILE PAPERS

PROGRESS IN TEXTILE MANUFACTURING. Contributed by the Textile Division. Executive Committee: Edwin H. Marble, *Chairman*, McRea Parker, *Vice-Chairman*, Wm. L. Conrad, *Secretary*, Earle R. Stall, Henry M. Burke, and Paul A. Merriam. [Paper No. TEX-52-1]

Improvements in textile machinery and methods have resulted in a greatly improved product. The report outlines developments in spinning, weaving, dyeing, bleaching, finishing, and knitting.

DESIGN AND OPERATION OF RANGE OR IN-TRAIN DRIVES FOR FINISHING PLANTS. By Wendell S. Brown. [Paper No. TEX-52-2]

Marked progress is being made toward grouping finishing-plant machinery in series or in ranges. This, among other important advantages, eliminates intermediate handling. Range drives may be divided into three classes:

1 Adjustable-speed motors, which include direct-current constant-voltage equipment, direct-current multi-voltage equipment, and alternating-current equipment.

2 Constant-speed motors or mechanically driven shafts, speed adjustment being obtained through such a device as the mechanical variator.

3 Adjustable-speed steam-engine drives.

Range drives prove advantageous in many combinations, from cloth in the rope form to cloth in the open form. Examples are given.

The successful operation of finishing machinery in ranges is dependent upon the attainment of certain advantages, such as elimination of in-between losses, improved uniformity and quality of product, saving in power and maintenance expense, and saving in executive work.

There are also certain possible disadvantages, such as the present market tendency toward a multiplicity of small lots and varied styles, and the demand for samples. Range speeds are limited to that of the slowest member, breakdowns tie up production, additional building construction is necessary to accommodate extra length, operating losses due to cloth damage in earlier processes continue

unnecessarily through subsequent processes, and there is somewhat greater initial expense.

ADVANCES IN CONTROL OF PLAIN, CHASE, AND SCHREINER CALENDERS. By James A. Campbell. [Paper No. TEX-52-3]

A better product from the textile finishing plants has resulted in the past few years, together with greater economies in the processing of goods, as the result of scientific study to obtain the facts. To operate at a profit the modern plant must meet present economic conditions by taking advantage of every opportunity to improve on quality and process. Calendering has become a most important process, as a larger proportion of cotton materials are now so treated; and the paper compares the principles, the designs of machines used, the methods of operation, and amount of production at the present time compared with 1910.

THEORY AND PRACTICE IN TEXTILE DRYING. By B. R. Andrews. [Paper No. TEX-52-4]

Drying is one of the large cost items in manufacture of textiles. The author gives costs of operation in unit production, and discusses points that contribute to maximum capacity and which should receive consideration.

PRESENT STATUS OF MEASURING PHYSICAL PROPERTIES OF TEXTILES. By W. F. Edwards. [Paper No. TEX-52-5]

Methods used to measure physical properties of textile yarns and fabrics so as to give numerical values to the properties in terms of defined units are discussed by the author. A machine and regain weighing device to do away with the drying operation and furnish the correct reading directly from the dial of the machine is described.

WOOD INDUSTRIES PAPERS

PROGRESS IN THE WOOD INDUSTRIES. Contributed by the Wood Industries Division. Executive Committee: Wm. Braid White, *Chairman*, Chester L. Babcock, *Secretary*, James S. Mathewson, Thos. D. Perry, and A. S. Kurkjian. [Paper No. WDI-52-1]

Substantial progress throughout American woodworking and wood-using industries is reported for 1929 in all technical and commercial aspects. In the field of woodworking machinery there is a strong tendency toward the use of individually motorized machines. Moreover electric current as the power source has now become so common a feature of woodworking factories as no longer to call for special comment. This again is leading to the general adoption of a standard of current, in this case alternating, at 60 cycles. Research in many fields is being carried on at the Forest Products Laboratory.

MODERN METHOD OF MANUFACTURING CLASSICAL FURNITURE By Harry Kimp. [Paper No. WDI-52-2]

Modern methods of manufacturing classical furniture eliminate nearly all hand operations. They are simplified by the use of the "rod" drawn on basswood to full size, from which measurements are taken by workmen for the construction of each piece of a suite. In this paper the author describes a process for preparing and drying lumber through various machine operations from the start to the completed furniture, preparatory to shipment.

FROM THE MASTER CABINETMAKERS TO WOODWORKING MACHINERY. By J. D. Wallace and Margaret S. Wallace. [Paper No. WDI-52-3]

This includes a history of woodworking machinery from the earliest times to the present. Some topics discussed include the medieval carpenter, master cabinetmakers, French influence, early hand tools, Bentham's planer, and the Newberry bandsaw.

FIRESAFE LUMBER. By Raymond W. Storm. [Paper No. WDI-52-4a]

Methods are given of rendering wood non-inflammable by impregnation with various chemicals in aqueous solutions, together with the subsequent drying of the treated lumber and the important characteristics of the products thus produced. The author has sought to emphasize mainly the commercial or practical side of manufacture and use rather than the purely technical or theoretical aspects of "Firesafe" wood.

MEASURING FIRE RESISTANCE OF WOOD. By T. R. Truax and C. A. Harrison. [Paper No. WDI-52-4b]

The Forest Products Laboratory has devised the fire-tube test to measure accurately in definite terms the property of wood to resist the spread of flame. As an acceptance test, the fire-tube method promises to be useful in evaluating the factors and conditions which affect the fire resistance of wood, as well as a means of working out the problems of those in the business of treating wood with fire retardants.

END-MATCHING, EDGE-JOINTED, AND SURFACE-LAMINATED WOOD PARTS FOR AUTO-BODY BUILDING. By G. G. White. [Paper No. WDI-52-5]

Advantages and savings from cutting lumber to final dimensions at the point of supply are discussed in this paper. Freight charges on waste and on the moisture removed in kiln drying are saved. In addition a lower grade of lumber can be used, and by cutting to size and shipping in bundles, the cost of handling is reduced and much less storage space is needed.

NOTE: Those who have not registered in the A.S.M.E. Aeronautical, Textile, and Woodworking Divisions whose papers are abstracted on this and the previous page, and who desire copies of any of these papers, may obtain them by using the form given below.

TO THE SECRETARY, A.S.M.E., 29 West 39th Street, New York, N. Y. Date.....

Please send copies of papers checked below:

Aeronautics [AER-52-8] [AER-52-9] [AER-52-10] [AER-52-11] [AER-52-12] [AER-52-13] [AER-52-14]
[AER-52-15] [AER-52-16] [AER-52-17] [AER-52-18] [AER-52-19] [AER-52-20] [AER-52-21]
[AER-52-22] [AER-52-23] [AER-52-24]

Textiles [TEX-52-1] [TEX-52-2] [TEX-52-3] [TEX-52-4] [TEX-52-5]

Woodworking [WI-52-1] [WI-52-2] [WI-52-3] [WI-52-4a] [WI-52-4b] [WI-52-5]

PRINT name (Important).....

Street Address..... City.....

A.S.M.E. 1930 Annual Meeting Papers

Available About November 15 in Pamphlet Form; Order by Number—Order Blank on Page 1030

(1) ALFORD, LEON P., Management's Responsibility for Industrial Accidents
(2) BAILEY, CHARLES F., Apprentice Training in Virginia
(3) BARNABY, R. S., Gliders
(4) BARRETT, A. W., Design of the Miller Simplex Automatic Two-Revolution Cylinder Press
(5) BAUDOIN, L. A., Lubrication of Textile Machinery
(6) BAUGHER, J. W., JR., Transmission of Torque by Means of Press and Shrink Fits
(7) BECKER, E. A., GORDON, E. E., and WISSLER, W. A., Stellite Cutting Tools
(8) BONNER, F. E., Federal Water Power Policies
(9) BOSTON, O. W., Machining Properties of Some Cold-Drawn Steels
(10) BROWN, HYLTON R., Dust Explosions, With Special Reference to Woodworking Industries
(11) CHANEY, LUCIAN W., Engineering Revision, The Essential in Casualty Reduction
(12) CLARK, C. L., and WHITE, A. E., Properties of Non-Ferrous Alloys at Elevated Temperatures
(13) CLARK, C. L., and WHITE, A. E., Comparative Physical Properties of Chromium-Nickel, Chromium-Manganese, and Manganese Steels
(14) CLARK, WALLACE, American Management in Europe
(15) CROCKER, SABIN, and MCCUTCHAN, A., Frictional Resistance and Flexibility of Seamless Tube Fittings Used in Pipe Welding
(16) D'ARCAMBAL, A. H., Tool-Steel Tools
(17) DEBAUFRE, WM. L., Heat Absorption in Water-Cooled Furnaces
(18) ENGLISH, FRED S., Some Problems in Standardization
(19) FALK, HAROLD S., Apprentice-Training Movement in Wisconsin Industry
(20) FREYSS, PIERRE, and HARDECKER, JOHN F., Interior Design of the Airplane
(21) GILBERT, E. M., Operation of the Holland Station
(22) GOODIER, J. N., Vibrations of Railway Bridges
(23) HAMILTON, KENNETH D., Material Handling in the Shoe Industry
(24) HARRIS, ALFRED S., Design of the New Harris Automatic Two-Color Flat-Bed Press
(25) HARRISON, R. E. W., and SAWYER, C. B., Survey of Surface Quality Standards and Tolerance Costs Based on 1929–1930 Precision-Grinding Practice
(26) HIRSHFELD, C. F., High-Pressure and High-Temperature Steam
(27) HOTTEL, H. C., Radiant-Heat Transmission Between Surfaces Separated by Non-Absorbing Media
(28) HURSH, R. K., Comparative Resistance of Refractories to Coal-Ash Slags
(29) IRWIN, K. M., Operating Experiences, Deepwater Station
(30) KINGSBURY, ALBERT, On Problems in the Theory of Fluid-Film Lubrication, With an Experimental Method of Solution
(31) KLINEFELTER, T. A., and REXFORD, E. P., Action of Slags on Firebrick and Boiler-Furnace Settings
(32) LARSON, CLIFFORD M., Evaluation of Steam-Turbine Oil Stability
(33) LAWRIE, JAMES W., Wood Research
(34) LINDSAY, DANIEL C., Psychometry and the Effects of Air Conditions on Some Familiar Products
(35) MACCUTCHEON, A. M., Special Applications of Electric Motors in Cloth-Finishing Plants
(36) MARRIOTT, JOS. S., Opportunities for Aviation Training
(37) MAYNARD, CHAS. EDGAR, Materials-Handling Methods in the Fisk Tire Plant
(38) NADAI, A., Plastic Torsion
(39) NITCHIE, CHAS. C., Application of Spectroscopic Apparatus to Industry
(40) O'NEILL, JAMES G., The Work Factor of Lubricating Oil
(41) PASINI, ALBERT C., and SARRAF, EDWARD M., Furnace-Gas Compositions and Temperatures in Underfeed-Stoker-Fired Boilers and Their Effect on Boiler Settings
(42) PATTERSON, R., and HARMS, D. H., Stresses in Retaining and Centering Rings
(43) PORTER, FREDERIC P., A Simple Method for the Calculation of Natural Frequencies of Torsional Vibration
(44) PRATT, P. P., Handling Materials at The Postum Company, Inc.
(45) REIMAN, C. R., Sizes and Tolerances for Metal Fits
(46) RHODES, GEO. I., and HILL, EDGAR G., Some Features of the Long-Distance Transportation of Natural Gas
(47) ROOSEN, R., The Stug System of Pulverized-Fuel Firing on Locomotives
(48) RUSHING, F. C., Determination of Stresses in Rotating Disks of Conical Profile
(49) RYAN, WM. F., Combined Heat and Power Supply in Industrial Plants
(50) ST. CLAIR, L. J., Cemented Tungsten Carbide as Applied to Cutting Tools
(51) SANDELL, MAYNARD L., Uses of 16-Mm. Movies in Industry
(52) STEPANOV, JOS. S., A Method for Standardization of Centrifugal Pumps
(53) STEVENS, B. D., and GOLBER, H. E., Forces in Connection With the Reciprocating Beds of Flat-Bed Cylinder Printing Presses
(54) SYMINGTON, T. H., Research Relating to the Action of 4-Wheel Freight-Car Trucks
(55) THOMPSON, EUSTIS H., Crane Lubrication
(56) WHITTEMORE, N. E., Materials Handling in Warehouses
(57) WOOD, B. F., Engineering Aspects of Interchange of Power with Industrial Plants
(58) Lubrication Research Activities. Fifth Report of A.S.M.E. Special Research Committee on Lubrication
(59) Elastic and Inelastic Behavior in Spring Materials. Progress Report No. 7 of A.S.M.E. Special Research Committee on Mechanical Springs, M. F. SAYRE
(60) Design of a Conical Spring With Coils of a Uniform Slope. Progress Report to the A.S.M.E. Special Research Committee on Mechanical Springs. JOS. B. REYNOLDS, and O. B. SCHIER
(61) Progress Report No. 1 of the A.S.M.E. Special Research Committee on Airplane Vibration, With Special Reference to Instruments

A.S.M.E. Annual Meeting Program

New York, December 1 to 5, 1930

MONDAY, DECEMBER 1

9:30 a.m. Council Meeting
Conference of Local Sections' Delegates
Simultaneous Sessions:

Applied Mechanics (I)

Determination of Stresses in Rotating Disks of Conical Profile, F. C. RUSHING
Stresses in Retaining and Centering Rings, R. PATTERSON and D. H. HARMS

Lubrication Engineering

Progress Report of Petroleum Division (*by title*)
Crane Lubrication, EUSTIS H. THOMPSON
The Work Factor of Lubricating Oil, JAMES G. O'NEILL
Evaluation of Steam-Turbine-Oil Stability, CLIFFORD M. LARSON

12:30 p.m. Luncheon, Council and Local Sections' Delegates

2:00 p.m. Council Meeting
Conference of Local Sections' Delegates
Simultaneous Sessions:

Applied Mechanics (II)

Plastic Torsion, A. NADAI
Vibrations of Railway Bridges, J. N. GOODIER

Materials Handling (I)

Handling Materials at the Postum Company, Inc., P. P. PRATT
Materials Handling in the Shoe Industry, KENNETH D. HAMILTON
Materials-Handling Methods in The Fisk Tire Plant, CHAS. EDGAR MAYNARD

Symposium on Industrial Accident Prevention

Economic Aspects of Industrial Casualty Reductions, L. W. WALLACE
Engineering Revision—The Essential in Casualty Reduction, L. W. CHANEY
Management's Responsibility for Industrial Accidents, L. P. ALFORD

8:00 p.m. Business Meeting

8:30 p.m. Art and Industry Exhibit

TUESDAY, DECEMBER 2

8:30 a.m. Lecture on Public Speaking, DR. S. MARION TUCKER, Head Dept. of English, The Polytechnic Institute, Brooklyn, N. Y.

9:30 a.m. Conference of Local Sections' Delegates
Simultaneous Sessions:

Hydraulic

Progress Report of Hydraulic Division, BYRON E. WHITE
Federal Water-Power Policies, F. E. BONNER
A Method for the Standardization of Centrifugal Pumps, JOS. S. STEPANOV

Machine-Shop Practice (I)

Survey of Surface Quality Standards and Tolerance Costs Based on 1929–1930 Precision-Grinding Practice, R. E. W. HARRISON, with Appendix by C. B. SAWYER
Transmission of Torque by Means of Press and Shrink Fits, J. W. BAUGHER, JR.

Railroad (I)

Progress Report of Railroad Division
High-Pressure and High-Temperature Steam, C. F. HIRSHFELD

Materials Handling (II)

Progress Report of Materials Handling Division (*by title*)
Materials Handling in Warehouses, N. E. WHITTEMORE

2:00 p.m. Conference of Local Sections' Delegates
Simultaneous Sessions:

Machine-Shop Practice (II)

Uses of 16-Mm. Movies in Industry, MAYNARD L. SANDELL
Application of Spectroscopic Apparatus to Industry, CHARLES C. NITCHIE

Industrial Power

Engineering Aspects of Interchange of Power With Industrial Plants, B. F. WOOD
Combined Heat and Power Supply in Industrial Plants, W. F. RYAN (*both re-presented from World Power Conference*)

Railroad (II)

Research Relating to the Action of 4-Wheel Freight-Car Trucks, T. H. SYMINGTON
The Stug System of Pulverized-Fuel Firing on Locomotives, R. ROOSEN

2:00 p.m. Session on—

Materials Handling (III)

For manufacturers of materials-handling equipment. Presentation of report and prospectus of committee. Discussion of proposed program of activities

8:30 p.m. President's Night
Reception and Dance

WEDNESDAY, DECEMBER 3

8:30 a.m. Lecture on Public Speaking, DR. S. MARION TUCKER, Head Dept. of English, The Polytechnic Institute, Brooklyn, N. Y.

9:30 a.m. Simultaneous Sessions:

Textile

Progress Report of Textile Division
Special Applications of Electric Motors in Cloth-Finishing Plants, A. M. MACCUTCHEON
Lubrication of Textile Machinery, L. A. BAUDOIN

Fuels

Progress Report of Fuels Division, T. A. MANGELSDORF
Heat Absorption in Water-Cooled Furnaces, WM. L. DE BAUFRE
Radiant-Heat Transmission Between Surfaces Separated by Non-Absorbing Media, H. C. HOTTEL

Stabilization of Employment

Discussion to be led by EDWIN S. SMITH

General

Machining Properties of Some Cold-Drawn Steels, O. W. BOSTON
Frictional Resistance and Flexibility of Seamless Tube Fittings in Pipe Welding, SABIN CROCKER and A. MCCUTCHAN

12:15 p.m. Luncheon, Council and Student Branches

2:00 p.m. Conference of Student Branch Delegates

2:00 p.m. Simultaneous Sessions:

Apprentice Training

Apprentice Training in Virginia, C. F. BAILEY
Apprentice-Training Movement in Wisconsin Industry, HAROLD S. FALK
Opportunities for Aviation Training, JOSEPH S. MARRIOTT

Steam Tables

Safety and Wood Industries

Dust Explosions With Special Reference to Woodworking Industries, Hylton R. Brown
Wood Research, James W. Lawrie
Progress Report of Wood Industries Division, Thomas D. Perry

6:30 p.m. Annual Dinner to New Members. Address, "Can the Engineer Be a Man?" by Elliott Dunlap Smith, Professor of Industrial Engineering, Yale University, New Haven

THURSDAY, DECEMBER 4

8:30 a.m. Lecture on Public Speaking, Dr. S. Marion Tucker, Head Dept. of English, The Polytechnic Institute, Brooklyn, N. Y.

9:30 a.m. Simultaneous Sessions:

Management

American Management in Europe, Wallace Clark

Central-Station Power

Operating Experiences, Deepwater Station, K. M. Irwin
Operation of the Holland Station, E. M. Gilbert

Aeronautics

Gliders, R. S. Barnaby
Interior Design of the Airplane, Pierre Freyss and John F. Hardecker
Progress Report No. 1 of the A.S.M.E. Special Research Committee on Airplane Vibration, With Special Reference to Instruments
Progress Report of Aeronautic Division

Cutting Metals

Tool-Steel Tools, A. H. d'Arcambal
Cemented Tungsten Carbide as Applied to Cutting Tools, L. J. St. Clair
Stellite Cutting Tools, E. A. Becker, E. E. Gordon, and W. A. Wissler

12:30 p.m. Luncheon, Honorary Chairmen of Student Branches

2:00 p.m. Simultaneous Sessions:

Oil and Gas Power

Progress Report of Oil and Gas Power Division, M. J. Reed
Some Features of the Long-Distance Transportation of Natural Gas, Geo. L. Rhodes and Edgar G. Hill
A Simple Method for the Calculation of Natural Frequencies of Torsional Oscillation, Frederic P. Porter

Fluid Flow

Reports of six sub-committees and rough drafts of Parts 2 and 3 of Fluid Meters Committee Report

Boiler-Furnace Refractories

Comparative Resistance of Refractories to Coal-Ash Slags, R. K. Hursh
Action of Slags on Firebrick and Boiler-Furnace Settings, T. A. Klinefelter and E. P. Rexford
Furnace-Gas Compositions and Temperatures in Underfeed-Stoker-Fired Boilers and Their Effect on Boiler Settings, Albert C. Pasini and Edward M. Sarraf

3:00 p.m. Ladies' Tea at Museums of the Peaceful Arts, 220 E. 42d St.

Evening College Reunions

FRIDAY, DECEMBER 5

9:30 a.m. Council Meeting
Simultaneous Sessions:

Symposium on Flat-Bed Cylinder Presses

Some Problems in Standardization, Fred S. English
Design of the New Harris Automatic Two-Color Flat-Bed Press, Alfred S. Harris
Report on Progress in Printing, Winfield S. Huson (*Presented by title*)

Lubrication Research

On Problems in the Theory of Fluid-Film Lubrication, With an Experimental Method of Solution, Albert Kingsbury
Lubrication Research Activities. Fifth Report of A.S.M.E. Special Research Committee on Lubrication

Properties of Metals

Properties of Non-Ferrous Metals at Elevated Temperatures, C. L. Clark and A. E. White
Comparative Physical Properties of Chromium-Nickel, Chromium-Manganese, and Manganese Steels, C. L. Clark and A. E. White

2:00 p.m. Simultaneous Sessions:

Refrigeration—Joint Session With A.S.R.E.

Effect of Humidity on the Heat Transmission of Galvanized Pipe, W. R. Woolrich (A.S.R.E.)
Psychometry and the Effects of Air Conditions on Some Familiar Products, Daniel C. Lindsay (A.S.M.E.)

Mechanical Springs

Elastic and Inelastic Behavior in Spring Materials. Progress Report No. 7 of A.S.M.E. Special Research Committee on Mechanical Springs, M. F. Sayre
Design of a Conical Spring With Coils of a Uniform Slope. Progress Report to the A.S.M.E. Special Research Committee on Mechanical Springs, Jos. B. Reynolds and O. B. Schier

Symposium on Flat-Bed Cylinder Presses (Cont'd)

Five-Minute Talk on Safety. The Relation of Safety to the Printing Industry, Robt. R. Elberty
Sizes and Tolerances for Metal Fits, C. R. Reiman
Design of the Miller Simplex Automatic Two-Revolution Cylinder Press, A. W. Barrett
Forces in Connection With the Reciprocating Beds of Flat-Bed Cylinder Printing Presses, B. D. Stevens and H. E. Golber

Synopses of A.S.M.E. Annual Meeting Papers

THESE papers, abstracts of which are being published on this and the following pages, are being printed in pamphlet form for the 1930 A.S.M.E. Annual Meeting. They may be secured by filling out the blank on page 1030 of this issue. Order by number, using the list given on page 1020.

AERONAUTICS

THE TREND OF GLIDER DESIGN AND OPERATION IN THE UNITED STATES. By Ralph S. Barnaby, Lieutenant, Construction Corps., U. S. N., Washington, D. C.

Gliding, that is, coasting down hill on the air, is a good sport; it is the next step for the aeronautically minded youth after the model-airplane building and flying stage; it teaches the fundamental principles of flying, and as such can be an aid in flight training; it is a stepping stone to soaring, the ultimate in flying.

Gliders and gliding methods employed in the United States are gradually getting away from those used in Germany, the parent country of the modern glider movement. A new type of glider, the "utility" glider, peculiar to the United States, has been produced. This is the result of terrain, economics, and the American mind. This glider is a cross between the German primary and secondary types.

The development of high-performance gliders or soaring planes has been slow in starting here. However, it is certain that when it has crystallized, the American soaring plane will also be somewhat different from its German counterpart.

INTERIOR DESIGN OF THE AIRPLANE. By Pierre Freyss and John F. Hardecker, respectively, F. Schumacher and Company, New York, N. Y., and Philadelphia, Pa.

The intense interest in the development of the interior design of the airplane is the national consequence of the competition between the airplane, the Pullman car, the automobile, and the motor bus for the patronage of the general public. Appealing as the plane does to that class whose time is of extreme value, it must offer a degree of comfort, convenience, and luxury comparable with other means of transportation.

While essentially a problem of the decorator, interior design demands the whole-hearted cooperation of the aeronautical engineer. It must be always in mind from the inception of the structural design, so that the maximum of opportunity for eye appeal is assured the decorator. Wall, ceiling and floor treatments, hardware, sanitary equipment, accessories, chairs, windows, doors, soundproofing, and fireproofing, all are within the scope of interior design. All must be blended into a harmonious whole, keeping ever in the forefront of the design the fundamental aeronautical requirements of minimum weight and maximum space utilization.

OPPORTUNITIES FOR AVIATION TRAINING IN THE AERONAUTICAL INDUSTRY. By Joseph S. Marriott, Chief, Inspection Service, Aeronautics Branch, Department of Commerce, Washington, D. C.

In this paper the author sets forth the possible methods of obtaining adequate instruction and training to enter the aviation industry either as a pilot or in a ground capacity. The article is written from the practical viewpoint of training facilities available in the industry itself, rather than opportunities presented by strictly educational institutions such as secondary schools and universities. The author also points out some of the advantages and disadvantages that are apparent in the existing means of obtaining aviation training.

APPLIED MECHANICS

VIBRATIONS OF RAILWAY BRIDGES. By J. N. Goodier, University of Michigan, Ann Arbor, Mich.

The paper contains a discussion of the nature of the approximately resonant vibrations of bridges due to the pulsating forces generated by unbalanced drivers, the influence of the motion of the train, and possible action of the springs; a group of proposed approximate formulas for predicting the natural frequencies of bridges, whether unloaded or supporting trains; a description of the methods of measuring natural frequencies; a list of the sources of damping; a theoretical demonstration of the effects of a small amount of distributed damping in restraining the forced vibration; and an appendix in which the frequency formulas are derived.

PROGRESS REPORT ON THE DESIGN OF A CONICAL SPRING WITH COILS OF A UNIFORM SLOPE. By Joseph B. Reynolds and Oscar B. Schier, respectively, in Charge of Research Work, and Research Assistant, for the A.S.M.E., at Lehigh University, Bethlehem, Pa.

This progress report presents the work accomplished during the first year at Lehigh University. Care has been taken to have the best designs possible, and for this reason few actual results can be given in this report.

The problem as presented to this research station was to develop and investigate a conical spring that would not fail under continuous operation, as does the conical spring of uniform pitch. The general plan of investigation was to design and prepare two series of springs, which differed only in respect to pitch and slope of coils, and to compare the performance of these springs. The mathematical design of the conical spring of constant slope was developed by Prof. J. B. Reynolds, while the design and supervision of the construction of the mandrels for winding the springs and the arbors for holding them during heat treatment was the work of O. B. Schier. Considerable attention was given to detail to provide a solid foundation for the work to follow.

ELASTIC AND INELASTIC BEHAVIOR IN SPRING MATERIALS (Contd.). Progress Report No. 7 of the A.S.M.E. Special Research Committee on Mechanical Springs (Technological). By M. F. Sayre, Supervisory Member in Charge of Research at Union College, and Associate Professor of Applied Mechanics, Union College, Schenectady, N. Y.

As suggested at meetings of the committee held a year ago, work during the past year under the auspices of the committee at Union College has been divided between a continuation of the fundamental studies previously stated, and some items of work of a more immediately practical nature. Progress Report No. 2 belongs in the second class. The present report describes the results obtained to date in connection with the more fundamental studies of the elastic behavior of spring materials.

These results may be summarized as follows:

1 A new method of work has been adopted, by which a greatly increased order of accuracy has been obtained in studies of behavior of spring materials in tension. Using a 52-ft. gage length, with dead-weight loading, under carefully controlled temperature conditions, readings of elongation can be taken to one part in fifteen million on the total length of the wire sample, with a probable mean accuracy under favorable conditions of one part in one million.

2 Measurements obtained by this method have confirmed in general the tentative conclusions suggested in Progress Report No. 5. In particular it is now possible to give numerical values for the rate of change of Young's modulus of elasticity with stress increase.

3 Tests have confirmed the general principle of a decrease in modulus of elasticity in tension as a result of previous overstrain in tension.

PLASTIC TORSION. By A. Nadai, Research Laboratories, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Among the locally varying distributions of stress with partial yielding, that of a twisted bar is treated for which the transition from a state of equilibrium with purely elastic deformations to one with plastic deformations was investigated. An analogy described on an earlier occasion was utilized to determine by an experimental method the distribution of stress in the twisted bar. This distribution of stress was compared with the position of the thin layers of slip observed in the etched cross-sections of twisted steel bars.

STRESSES IN RETAINING AND CENTERING RINGS FOR TURBINE-GENERATOR ROTORS. By R. Patterson and D. H. Harms, General Electric Company, Schenectady, N. Y.

In this paper the authors deal theoretically with the distribution of stresses throughout the system of parts enclosing the rotor coil ends of a turbine generator. This system of parts consists of a disk of uniform cross-section, a cylinder, and a part of the shaft. These parts are fastened together by means of fairly heavy shrink fits and therefore, in the development of formulas for the stresses, the effect of this shrinkage, as well as that of rotation, must be considered.

Since these parts must remain integral for the design considered, the importance of being able to predetermine the speeds at which the various parts may become free is apparent. Therefore formulas were developed for these speeds subject to the boundary conditions which were set up. An example is given for which the distribution of stresses for two cases are plotted. These two cases are respectively for the generator at standstill and at operating speed. A summary of the significant results is given at the beginning, and a discussion of the main points of interest at the close of the paper.

PROBLEMS IN THE THEORY OF FLUID-FILM LUBRICATION, WITH AN EXPERIMENTAL METHOD OF SOLUTION. By Albert Kingsbury, President, Kingsbury Machine Works, Frankford, Philadelphia, Pa.

Analytical treatment of problems in perfect film lubrication is in general very difficult; solutions have thus far been obtained only in a few relatively simple cases. The paper describes methods by which fairly accurate solutions of any stated cases may be obtained experimentally, through the analogy between electrical potential and current flow in a conductor, and pressure and volume flow in the lubricating film. Electrical measurements are made upon enlarged models of the lubricating films, the models being bodies of conducting fluid contained in wooden boxes having forms determined by theory. Pressures at points in a film having been deduced from the electrical data, graphical or other means of integration are used to determine the total load, the friction, and the quantities of oil flow at the edges of the film. The method is not limited as regards the shape of the film or variation of viscosity within the film. Solutions are given for a number of cases of plane bearing surfaces and journal bearings, showing close agreement with analytical solutions in cases where the latter have been obtained.

DETERMINATION OF STRESSES IN ROTATING DISKS OF CONICAL PROFILE. By F. C. Rushing, Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.

In this paper the accuracy of stress-distribution curves obtained by the application of Donath's "Sum and Difference Curves" to rotating disks of conical profile is determined.

LUBRICATION RESEARCH ACTIVITIES. Fifth Report of A.S.M.E. Special Research Committee on Lubrication.

A new general program for experimental work and publications recently formulated by the committee is outlined in this report, and is followed by a brief statement of results already obtained. Particular attention has been given to the coordination of data obtained by various investigators on viscosity under high pressure; to the study of pressure distribution in the oil film as applied to both thrust bearings and journal bearings; and to the development of methods for measuring oiliness. From experiments on the flow of liquids through very fine glass and platinum capillaries, it appears that the ordinary laws of viscosity may safely be relied upon down to film.

FUELS AND STEAM POWER

HEAT ABSORPTION IN WATER-COOLED FURNACES. By Wm. L. DeBaufre, International Combustion Engineering Corporation, New York, N. Y.

Based on the furnace heat balance, an empirical "effectiveness factor" is derived for water-cooled surfaces therein, relating to the heat radiated by the burning fuel and products of combustion to the furnace outlet temperature. The value of this factor is calculated from certain experimental data for turbulent horizontally fired pulverized-coal furnaces with bare water-cooled tube walls. For these experimental data, the fraction radiated of the heat liberated in the furnace has also been calculated and is compared with Broido's curve and with the value calculated by the Orrok-Hudson formula. The method of applying the effectiveness factor to design problems is illustrated by showing the effect of preheated-air temperature upon the furnace outlet temperature.

OPERATION OF THE HOLLAND STATION. By E. M. Gilbert, Chief Engineer, W. S. Barstow and Company, Reading, Pa.

The Holland plant, being among the first plants designed exclusively for high-pressure steam, is now in operation, and the experiences obtained during operation are of interest. The main features of the plant are a 55,000-kw. high-pressure and low-pressure turbine designed for variable-load operation; two similar boilers, each with its reheater built integral, designed for generating 250,000 lb. per hr. each; elimination of the wall between turbine and boiler room; and control centralized on the operating floor.

The operating experiences with the different elements of the plant are given, together with data showing the operating results for the six-month period. Operating results, while of short duration, show justification of the use of higher pressures from an economic standpoint.

RADIANT-HEAT TRANSMISSION BETWEEN SURFACES SEPARATED BY NON-ABSORBING MEDIA. By H. C. Hottel, Fuel and Gas Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Fundamental laws of radiation from solids have been discussed and applied to individual problems of heat transfer in numerous papers. In this one the author indicates just what principles are involved, to how many problems they have been applied, and gives a number of applications of the principles to problems in industrial-furnace design.

Fundamental principles and definitions discussed include: The definition of normal intensity, Lambert's cosine principle, relation between intensity and emission power, the square-of-the-distance law, Kirchoff's law, and the Stefan-Boltzmann law. Various surface arrangements are divided into two groups: (1) in which one of the two surfaces is small relative to the distance separating them, and (2) in which both surfaces are of considerable extent relative to their distance apart. Various cases of these and the effect of incomplete absorption are treated mathematically. The task of applying many of the equations given in the paper is simplified by presentation of numerous graphs.

THE COMPARATIVE RESISTANCE OF REFRACTORIES TO COAL-ASH SLAGS. By R. K. Hursh, Professor, Department of Ceramic Engineering, University of Illinois, Urbana, Ill.

Tests have been made in the laboratory slagging-test furnace of various commercial refractories and of a series of special mixtures representing clays from three manufacturing districts, as well as differences in the method of fabrication, the firing treatment, and the fineness of grinding of the materials. The slags used were ashes from coals of five different districts.

The comparative resistance of refractories varied with the character of the coal ash. Dry-pressed and stiff mud bricks were more resistant than hand-made refractories. A moderate degree of firing treatment was preferable to hard burning when the brick were subjected to high furnace temperatures and slag action.

OPERATING EXPERIENCES—DEEPWATER STATION. By K. M. Irwin, Mechanical Engineer, United Gas Improvement Company, Philadelphia, Pa.

The first part of this paper gives a brief description of the physical characteristics of the Deepwater plant, emphasizing only those details which are relatively new, or those which have had a distinct bearing upon operating experiences. The rest is devoted to a history of the operations from the time the plant was first started in March, 1930, up until the present, summarizing the difficulties that have been encountered and attempting to segregate them between those that are directly chargeable to the pressure or temperature, and those which have been encountered due to other features of design.

Due to the fact that a large portion of the plant has only been in what might be termed commercial operating service since June, or for three months, at the time this paper was prepared, very few authentic data on operating efficiencies are given.

PROPERTIES OF NON-FERROUS ALLOYS AT ELEVATED TEMPERATURES. By C. L. Clark and A. E. White, respectively Assistant Investigator and Director of the Department of Engineering Research, and Professor of Metallurgical Engineering, Department of Engineering Research, University of Michigan, Ann Arbor, Mich.

This paper gives the results of an investigation of the properties of certain non-ferrous alloys at elevated temperatures as determined by short-time tensile and long-time creep tests. The alloys considered are of four groups which are the nickel-copper, nickel-cobalt-

titanium, copper-zinc, and copper-zinc-tin series. The alloys are tested at temperatures both above and below their lowest temperature of recrystallization.

Results indicate a superiority of the nickel-base alloys over the entire temperature range. The outstanding member of this group is Konel metal, which has short-time tensile properties at 1000 deg. fahr. comparable to Enduro KA[2], and the greatest creep resistance at this temperature of any alloy of which the authors are aware. Monel metal retains its properties well up to 800 deg. fahr.

Of the copper-zinc alloys those containing 70 per cent or more copper are superior to those with 60 per cent of this element. None of these alloys can be used at temperatures much above 400 deg. fahr. and for those containing lower amounts of copper, 300 deg. fahr. is believed to be the maximum working temperature if stresses of appreciable magnitude must be considered.

COMPARATIVE PHYSICAL PROPERTIES OF CHROMIUM-NICKEL, CHROMIUM-MANGANESE, AND MANGANESE STEELS. By C. L. Clark and A. E. White, respectively Assistant Investigator and Director of the Department of Engineering Research, and Professor of Metallurgical Engineering, Department of Engineering Research, University of Michigan, Ann Arbor, Mich.

This paper gives the results of short-time tensile tests at 75 and 1000 deg. fahr., and creep tests at 1000 deg. fahr. on certain selected steels. The steels investigated belong to either the chromium-nickel, the chromium-manganese, or manganese series. Certain other alloying elements as silicon and tungsten were also present. The chromium-nickel-steel specimens were taken from both bar and tube stock, and certain of them were tested in both the hot-rolled and water-quenched conditions.

The results indicate that the substitution of manganese for nickel in chromium-nickel steels is detrimental, at least in so far as the load-carrying ability of the alloy is concerned. Also that while the creep resistance at 1000 deg. fahr. of the manganese and manganese-tungsten steel is superior to that of many pearlitic steels, it is not equal to that of the Enduro KA[2] type of alloy.

FURNACE-GAS COMPOSITIONS AND TEMPERATURES IN UNDERFEED-STOKER-FIRED BOILERS AND THEIR EFFECT ON BOILER SETTINGS. By Albert C. Pasini and Edward M. Sarraf, respectively Technical Engineer, the Detroit Edison Company, Detroit, Mich., and Chemical Engineer, Harbison-Walker Refractories Company, Pittsburgh, Pa.

This paper is a study of conditions encountered in boiler furnaces using underfeed stokers. It includes the development of methods of test procedure and their application in investigating furnace-gas compositions, and for determining the temperatures to which the refractories of the setting are subjected. It contains a discussion of the effects of variation of the fuel-bed thickness on the brick in the settings, the efficiency of combustion, and the resultant superheated-steam temperatures. The paper further shows the widely divergent furnace-gas compositions which may be obtained directly over the fire along the wall in underfeed-stoker-fired installations.

ENGINEERING ASPECTS OF INTERCHANGE OF POWER WITH INDUSTRIAL PLANTS. By B. F. Wood, Allied Engineers, Inc., New York, N. Y.

Economical operation can be effected and overhead costs greatly reduced in a great many cases where public-utility or other steam-generating or hydro-power plants find it possible to hook up with large industrial operations. The advent of high steam pressures has largely increased these possibilities and extended the engineering problems involved in their proper solution. The engineer must seek the maximum overall economy with minimum investment, having regard for reliability of service, and then work out a plan for the undertaking that will be of equal advantage to all interested parties.

COMBINED HEAT AND POWER SUPPLY IN INDUSTRIAL PLANTS. By William F. Ryan, Mechanical Engineer, Stone & Webster Engineering Corporation, Boston, Mass.

The ever increasing demand for cheap power—the foundation of American industry—has been ably met by the public utilities in the past, and the industrial power engineer is now taking his part in promoting the productiveness of human labor. The use of high steam pressures has been the most noteworthy development in the industrial power field during the past few years. There are now about 200 industrial plants in the United States operating at pressures above 300 lb. gage, almost all of which have been built since 1925. The industrial plant which has a large demand for process steam has a natural advantage over the condensing central station, in that the latent heat in the exhaust is utilized, and the cycle efficiency of the prime movers is 100 per cent. The quantity of power which can be generated so economically is limited by the demand for exhaust steam, but can be materially increased by raising the throttle pressure.

There are few industries which can generate their entire power requirements, at all times, in all seasons, as a by-product of their process steam. There are still many such plants which generate power in condensing prime movers, but the vast majority purchase their requirements from public utilities. There is rarely any economic justification for the private generation of steam power in condensing units, although under certain conditions internal-combustion engines may be used advantageously. There is a growing tendency in this country to use the Diesel engine as an adjunct to an industrial steam power plant; when the electric-power demand exceeds the relative demand for exhaust steam, the deficiency is supplied by the Diesel engine.

There are many plant which have large demands for process steam, but relatively little demand for electric-power. The most significant trend in the industrial power field today is the cooperation of public utilities with manufacturing plants to develop "by-product" power to its economical limit. An example of such cooperation is cited in which the power output of an industrial plant is increased from 5500 kw. to 25,500 kw., the surplus power being distributed to other consumers over the transmission lines of the public utility. The fuel cost of the additional 20,000 kw. is less than 4500 B.t.u. per kw-hr. The combination results in a decrease of 10 per cent in capital cost and a decrease of 20 per cent in fuel consumption, as compared with the separate generation of electricity by the public utility, and the generation of power and heat by the industrial plant.

FRICTIONAL RESISTANCE AND FLEXIBILITY OF SEAMLESS-TUBE FITTINGS USED IN PIPE WELDING. By Sabin Crocker, Engineering Dept., Detroit Edison Co., and A. McCutchan, Detroit Edison Co., Detroit, Mich.

The trend toward the use of welded piping has led to the development of seamless-tube fittings. These fittings are a decided departure from both the cast fittings and long-radius pipe bends heretofore used, and their introduction has occasioned considerable speculation as to their relative merits and correct application. This paper is confined to a discussion of: (*a*) the relative friction loss in elbows and bonds of different radii; and (*b*) the relative flexibility of pipe lines made up with long-radius bends as distinguished from cast fittings and from seamless-tube fittings having a radius of $1^1/_2$ pipe diameters. The authors have compiled and analyzed the available data on friction loss in elbows and bends, and present a detailed comparison of the flexibility of piping made up with seamless-tube fittings, long-radius bends, and cast fittings. Seamless-tube fittings ($R/d = 1^1/_2$) are found to compare to advantage with the older types of construction in both phases considered.

ACTION OF SLAGS ON FIREBRICK AND BOILER-FURNACE SETTINGS. By T. A. Klinefelter and E. P. Rexford, respectively Supt. Columbus Branch, and Research Associate for A.S.M.E., Columbus Branch, Bureau of Standards, U. S. Department of Commerce, Columbus, Ohio.

The results contained in this paper were obtained in an investigation conducted by the Columbus branch of the U. S. Bureau of Standards for the A.S.M.E. Special Research Committee on Boiler-Furnace Refractories. The paper presents a rational discussion of the action of coal ash upon boiler-furnace refractory walls, and shows the consistency of results from the authors' laboratory slag tests with firebrick under actual service conditions in boiler furnaces.

HYDRAULICS

FEDERAL WATER-POWER POLICIES. By F. E. Bonner, Executive Secretary, Federal Power Commission, Washington, D. C.

With the amazing advances made in the production and distribution of electrical energy during the past decade, it is of interest to examine the part played by the Federal Government. This is particularly true of the water-power field where, through vast land holdings and constitutional authority in respect to navigation, the National Government exercises control over a large portion of the country's potential resources. During this period the administration of the law regulating the utilization of power sites involving Government interest has reposed with the Federal Power Commission. Although developments of many of the large rivers have been delayed by legislative embargoes and political controversy, the Com-

mission has authorized the construction of many important projects, and about 2,600,000 horsepower of capacity is now operating under license from the Commission. The proper division of authority between the Government and the states has raised some complex problems which are pressing for solution.

A METHOD FOR THE STANDARDIZATION OF CENTRIFUGAL PUMPS. By Joseph S. Stepanov, Worthington Pump and Machinery Corporation, Harrison, N. J.

The author adheres to the opinion that the combined application of the preferred-numbers idea and law of similitude provides a forceful means of eliminating unnecessary variety of sizes and of simplifying the tool machinery equipment in any field of industrial production.

In application of this method to the standardization of centrifugal pumps, the author develops a set of geometric series conforming to the preferred-numbers table. The formation of these series, their interconnections, and their use for treating the standardization problem are illustrated by numerical tables, charts, and diagrams.

Standardizations of hydraulic and mechanical parts of centrifugal pumps are tied together by the use of the law of similitude, resulting in the formation of a set of interconnected geometric series applicable to both cases.

MACHINE SHOP PRACTICE

TRANSMISSION OF TORQUE BY MEANS OF PRESS AND SHRINK FITS. By J. W. Baugher, Jr., Nuttall Works of the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.

The most important formulas for calculating the stresses existing in press and shrink fits are presented, together with charts for readily obtaining numerical results when steel shafts and cast-iron or steel outer members are used. Equations and charts are given also for determining the pressure existing between fitted parts. From the records of a number of fits observed by the author and others, values of coefficients of friction are suggested for use with the pressure in computing the probable tonnage required in making a fit and the torque capacity of a fit when no key is used. Equations are given for the tonnage and torque capacity.

A SURVEY OF SURFACE QUALITY STANDARDS AND TOLERANCE COSTS BASED ON 1929–30 PRECISION-GRINDING PRACTICE. By R. E. W. Harrison, and C. B. Sawyer, respectively, Engineering Director, Cincinnati Grinders, Inc., Cincinnati, Ohio, and President, Brush Laboratories, Cleveland, Ohio.

An earlier paper presented at a meeting of the Chicago Section of the A.S.M.E. in March, 1929, reviewed the process of evolution through which the art of precision cylindrical grinding had passed up to that date. This paper reviews some of the defects which exist in the present-day accepted standards of finish of mechanical components, and represents an endeavor to maintain continuity by carrying the discussion through to the present-day standards of finish attainable by the abrasive process. It is pointed out that it is useless to specify extremely close limits of accuracy unless the measurements are made across basically plane surfaces.

Size control and its effect on cost of production, as well as the length of useful life are discussed, and better finishes are advocated as a means of reducing the ill effects of high initial wear. A scheme for the establishment of definite standards of finish is put forward, and a finish-calibrating instrument is described. Emphasis is laid on the fact that there is no available short-cut method of obtaining ultra-fine finished surfaces with a minimum of initial wear, and the authors point out that standardization of finishes can be attained at low cost with very little disruption of present methods; also that the subject of longer useful life of mechanical components is closely interlocked with the provision of a better standard of finish, and the attendant benefits derived from close adherence to true limits of accuracy.

TOOL-STEEL TOOLS. By A. H. d'Arcambal, Consulting Metallurgist, Pratt and Whitney Company, Hartford, Conn.

Metal-cutting tools offered the trade today are vastly superior in quality to tools of a decade ago. The factors that govern the life of metal-cutting tools made from carbon, alloy, and high-speed tool steels, namely, design, steel, and treatment, are discussed in this paper, particular stress being laid on the importance of correct design.

The important role played by cutting fluids or coolants as affecting the life of the tool, as well as the necessity of employing the proper grinding wheels and correctly using them, are also covered in some detail.

STELLITE CUTTING TOOLS. By E. A. Becker, E. E. Gordon, and W. A. Wissler, the first two with Haynes and Stellite Company, Kokomo, Ind., and the latter with Carbide & Carbon Research Laboratories, Long Island City, N. Y.

This paper describes briefly the physical properties of Haynes Stellite and gives the more important details of several types of machining operations on which it is being successfully used. Its most important property is red-hardness. Measurements of hardness were made by an improved method up to 1100 deg. cent. the resulting data show that the cobalt-chromium-tungsten alloy is harder than high-speed steel at temperatures above 500 deg. cent. This is believed to account for its superior cutting quality.

When used for milling, three typical jobs on cast iron show 87, 100, and 27 per cent increased production, respectively, on high-speed steel. On boring cylinder blocks the increase was 64 per cent. Turning operations in cast iron show 33, 35, and 60 per cent increase in production, and on steel, 123 and 93 per cent.

In general, Stellite bits and blades can be used economically on all operations on cast iron, semi-steel, malleable iron, bronze, or similar metals, and on mild steel if the section is heavy and the tools are rigidly supported. It has not been successful on automatic or semi-automatic machines for cutting steel.

THE USES OF 16-MILLIMETER MOVIES IN INDUSTRY. By Maynard L. Sandell, Eastman Kodak Company, Rochester, N. Y.

Industrial motion pictures may be readily divided into two distinct classes, namely, institutional and internal. Institutional pictures include productions employed for sales promotion and advertising purposes, or for any other use involving public exhibition. Such films should be made by the professional producer of motion pictures on standard-size 35-mm. film. Internal uses include instructing employees in safety, in machine-shop practice, in plant housekeeping, in fire prevention, and making records of construction and research findings, of testing, assembling, sorting, and packing operations.

This paper deals only with the latter class, describes briefly some of the many internal uses of industrial motion pictures and tells members of the plant engineering staff how to make such movies on amateur standard 16-mm. film with inexpensive amateur equipment. To illustrate the paper, a collection of industrial movies will be shown.

CEMENTED TUNGSTEN CARBIDE AS APPLIED TO CUTTING TOOLS. By L. J. St. Clair, Manager, Philadelphia District, Carboloy Company, Inc., Philadelphia, Pa.

In this paper the author tells of the origin of cemented tungsten carbide and the most satisfactory method for making it. Because of its hardness its use for wear-resisting tools is valuable, and particular emphasis is placed on its use for cutting tools. The physical properties of cemented tungsten carbide and its economic value as a cutting medium are discussed. Design and care of the tools are essential factors in successful application. Proper support for the cemented-tungsten-carbide tip and allowance for proper clearance angles are essentials of design.

The tool set-up should be as rigid as possible, as chatter or vibration are detrimental to successful life. The critical speed at which the tool should run for a particular job should be determined and the machine operated below this. Grinding of the tool is important, and the author tells of proper grinding methods. Use of cemented tungsten carbide for cutting tools has resulted in increased machine speed, longer life per grind, reduced tool maintenance, less waste of material in setting up, and greater accuracy throughout a long run.

APPLICATION OF SPECTROSCOPIC APPARATUS TO INDUSTRY. By Charles C. Nitchie, Bausch & Lomb Optical Company, Rochester, N. Y.

Modern industry is rapidly adopting the methods and instruments of the theoretical scientist in its search for better means of determining the quality and properties of materials. Among these instruments the spectroscope and spectrograph are finding increasing use. Their particular field is the rapid detection and determination of those minute quantities of impurities and other minor constituents that often affect profoundly the physical properties of the materials containing them. A general description of the principles, instruments, and methods of use is followed by a brief discussion of some ways in which such methods are finding use in the industrial field.

MACHINING PROPERTIES OF SOME COLD-DRAWN STEELS. By O. W. Boston, University of Michigan, Ann Arbor, Michigan.

This paper gives the results of a series of machining tests on 13 cold-drawn screw-stock steels and 2 cold-drawn stainless steels. Machinability values for standardized conditions are given for each steel as follows: The force required to remove a chip by a planer tool; the energy required to remove a chip by a single-tooth milling cutter; the torque and thrust developed by a 3/4-in.-diameter drill; the penetration of a 1/4-in.-diameter drill under a constant feeding load. An attempt is made to correlate the results of these various machining tests with the Brinell, Rockwell, and scleroscope hardness values, as well as with the analysis and structure of each bar. Values representing the power required to cut 1 cu. in. of metal per minute under specific standardized conditions are given for planing, milling, and drilling the various steels.

MANAGEMENT

MANAGEMENT'S RESPONSIBILITY FOR INDUSTRIAL ACCIDENTS. By L. P. Alford, Vice-President, The Ronald Press Company, New York, N. Y.

"Who is responsible for an industrial accident?" This question has been a favorite topic of discussion since the beginning of the safety movement. Gradually there has come a change in the method of answer. At first the workman was held responsible for whatever befell him; now there are those who put by far the major part of the final responsibility for industrial accidents upon management.

This newer point of view insists that an industrial accident is evidence of some fault of control of the operating conditions and forces. For this control the executives and members of the supervisory force are responsible. One study assessed 88 per cent of all accidents against the supervisory force.

The Committee on Safety and Production, American Engineering Council, formulated this fundamental of management: "Maximum productivity is dependent upon the reduction of accidents to an irreducible minimum," and management "must initiate, direct, and control ways and means of keeping accident frequency and severity rates at an irreducible minimum."

THE APPRENTICE-TRAINING MOVEMENT IN WISCONSIN INDUSTRY. By Harold S. Falk, Vice-President and Works Manager, The Falk Corporation, Milwaukee, Wis.

The apprenticeship movement in Wisconsin has been made a concerted, organized effort. In developing the work, important considerations and tendencies have been taken into account: the shortage of skilled mechanics in American industries at the present time in spite of considerable unemployment, the requirements of production as well as jobbing industries for trained men, and the importance of the human factor in all industry.

Employers and employees have cooperated in the promotion and support of an apprenticeship law in the state which stabilizes and dignifies apprenticeship by preventing exploitation of boys and by setting standards of workmanship in the trade. As a result of public favor and the enthusiasm of influential individuals, apprentice training has developed rapidly in the state. Three thousand, three hundred and fifty apprentices are employed and 2567 have been graduated in the last 15 years. At the present rate of graduation, this number will be increased very much in the next 15 years.

The training of apprentices in the machinery-building industry of the state metropolis dates from the beginning of the century, and active apprenticeship committees have functioned in the Metal Trades Association ever since. The number of apprentices in the machinery-building industry of Milwaukee has grown from 460 in 1911 to 1068 at the present time.

ENGINEERING REVISION. By Lucian W. Chaney, Bureau of Labor Statistics, U. S. Department of Labor, Washington, D. C.

The expression "engineering revision" was devised to afford a compact expression for the widest possible application of engineering skill to the problems of safety in industry. The engineering factor has not hitherto been given all the credit deserved for its influences in the prevention of serious injury. A critical study of some departments of the iron and steel industry shows very clearly that engineering revision has, in that industry, been the important item. This conclusion is confirmed by the consideration of 372 cases of fatal injury.

The classification of fatal cases by the nature of injury and the bodily location further illuminates the contention of the importance of the engineering factor. Finally the careful appraisement by safety committees of some 1642 cases shows that when adequate attention is given "engineering revision" at once appears as of most importance in the control of serious injury.

APPRENTICE TRAINING IN VIRGINIA. By C. F. Bailey, Engineering Director, Newport News Shipbuilding and Dry Dock Company, Newport News, Va.

The South, including Virginia, is becoming industrially minded. This stresses the need for education for industries and the arts. The transportation companies, iron works, and shipbuilding require skilled mechanics, trained through apprenticeship. The primary principles in apprentice training are, (1) careful selection of candidates, (2) importance of the supervisor, and (3) the sympathy and aid of the management. Advantages of apprentice training include recruiting skilled mechanics with a spirit of loyalty and service, some of whom will develop to foremen and higher officials. To promote this, training schools in company's time are advisable. The apprentice group is to be self-governing.

AMERICAN MANAGEMENT IN EUROPE. By Wallace Clark, Consulting Management Engineer, New York, N. Y.

During three and a half years spent in the installation of American methods of management in a variety of plants and mines in nine different countries, the following characteristics of European industry have been noted:

Less mass production than in America because of tariff walls, different habits of peoples, and lower purchasing power.

Turnover of investment is slower due to less effective management.

Not enough practical men among the executives due to class distinctions.

Introduction of results of research into practice is slower.

More labor is wasted because wages are low.

More respect for knowledge and authority than in America.

Workman have greater security.

These characteristics of industrial conditions in Europe apply only partly to Great Britain and not at all to Russia. In the latter the fundamental structure produces different shop conditions. Installations of methods, as found, are most satisfactory when made by a combination of American and native engineers who train the clients' men, but do not undertake any executive work.

The following differences in the installation of the mechanisms of management are found:

In Europe more time is required to secure delivery of purchased materials.

The rearrangement of old buildings is more frequently necessary.

Reserved-time scheduling is more needed than chain production.

Market research and sales organization have not made much progress.

Budgeting is well understood.

Methods of executive direction are as much in demand as in America.

There is now in Europe a more general understanding of the fact that conditions are changing and that methods must be flexible.

PSYCHROMETRY, AND THE EFFECTS OF AIR CONDITIONS ON SOME FAMILIAR INDUSTRIAL PRODUCTS. By Daniel C. Lindsay, Physicist, Carrier Engineering Corporation, Newark, N. J.

Since the introduction of high-speed machinery in the textile industry, air conditioning or at least the control of humidity, has been a necessity regardless of the climatic location.

In the paper-manufacturing and printing industries, air conditioning has been applied to standardize weights and physical tests, to control the physical reactions of papers, inks and moisture-sensitive gelatine rollers from day to day.

Rayon, our third textile, produced by a vast highly developed chemical industry, demands technical control of air conditions through most all of its processes; likewise the kindred industries producing explosives and cellulose products.

Confections, cigars, cigarettes, cereals, dairy products, drugs, and pharmaceutics, rubber goods, clay products, and dozens of other products have been served by the science of air conditioning toward increased efficiency in production and improvement in quality.

Engineers and manufacturers quite generally have gained a knowledge of these applications. But the frequent instances of unfamiliarity with air conditions and the effects upon materials which have come to the attention of the author make it seem advisable to present again some of the simple methods of determining air temperature, the dewpoint temperature, relative humidity, the actual moisture content, etc.

Among the questions answered are: How the condensation of

moisture on and the consequent blushing of industrial lacquer may be foretold and prevented; why the mysterious condensation and consequent rusting on ball bearings and other metal objects in storage or shipment; and how the drying and crystallization of certain materials are controlled through the wet-bulb temperature.

MATERIALS HANDLING

MATERIALS-HANDLING METHODS IN THE FISK TIRE PLANT. By Charles Edgar Maynard, Factory Superintendent, the Fisk Rubber Company, Chicopee Falls, Mass.

This paper discusses the part that handling equipment has played in a program of cost reduction and quality improvement in the Fisk tire plant. In recent years there has been a tendency for the plant to become more "conveyorized," coordinating groups of operations. The trucking and mechanical departments are mainly responsible for the materials-handling equipment. The engineering division of the mechanical department, is expected to develop improvements.

The cost of improvements has to be justified by a reduction in operating cost or an improvement in quality. There are no limitations on the cost of materials-handling equipment provided a saving can be made within a reasonable length of time. Hopper systems and gravity conveyors have been installed in the compound department, resulting in a reduction in floor space and improvement in handling conditions. In the milling and calendering department several successful installations have been made, tying the milling directly to the calendering, thus eliminating trucking which formerly existed between these two operations. Coordinating the calender with some of the operations which follow it has been accomplished, particularly in calendering of treads. Conveyors are now being used to handle the cut material from the stock-preparation department to the tire department.

Along with the development of conveyors for eliminating trucking, a great many special trucks have been developed such as an electric truck for handling large rolls of rubber-coated materials, and trucks for handling treads and uncured tires. The tire-building department is fed by conveyors and its finished product, the uncured tires, is carried on conveyors to the curing department. An elaborate conveyor system of heavy construction is used in handling the mold equipment in the curing department. This system also assists in tying in the various pieces of equipment for curing, thus becoming an integral part of the process.

The inspection department is completely "conveyorized," using a series of belt conveyors and live-roller conveyors upon which a bank of tires can be maintained, thus insuring a steady flow of materials for the various operators located between the conveyors. A series of conveyors has been developed in the inner-tube department which assists in the process of manufacturing other than actually conveying the materials.

MATERIALS HANDLING IN THE SHOE INDUSTRY. By Kenneth D. Hamilton, Mechanical Engineer, George E. Keith Co., Brockton, Mass.

The subject which is discussed in this paper illustrates the growth of the shoe industry from its earliest establishment from the point of view of mechanical handling of products. It describes in detail the typical factory-production problem and the development of the mechanical conveyor in shoe factories. This discussion also touches on mechanical drying and tempering of leather, as well as the adaptation of the individual motor to shoe machinery. The installation of standard equipment for power house, dust collecting, packing, and shipping is also illustrated to show that the shoe industry is searching for all methods to reduce production costs. Shoe manufacturing is one of the oldest arts in the country, but is fast adapting itself to modern methods of production, not only as regards equipment, building, and power distribution, but also the latest phases of mass production relating to material-handling problems.

HANDLING MATERIALS AT THE POSTUM COMPANY, INC. By P. P. Pratt, Engineer, The Postum Company, Battle Creek, Mich.

This paper offers a discussion of various types of conveyors in general use, together with descriptions of a few specialized conveyors that may be of interest to engineers. Practically every phase of manufacturing at the Postum plant embraces operations performed on the material in course of handling; especially is this true of modern automatic packaging machinery, referred to in this paper.

An enlarged section treats the operation and mechanical details of the "Intercommunicating Pilot-Car Package-Conveying System," used as a connecting link between various shipping points.

MATERIALS HANDLING IN WAREHOUSES. By N. E. Whittemore, Director of Operations, First National Stores, Inc., Somerville, Mass.

The author treats the subject not as it applies to methods in general warehousing, but rather as it specifically appertains to warehousing in the chain-store industry.

The chain-store method of retail distribution of commodities originated in the grocery field in 1859. It has had its greatest growth, however, since 1910. Although early in the life of the majority of grocery chains, in an effort to simplify distribution, warehouses were established, such warehouses have been, until recent years, operated along old-fashioned lines, with little or no attempt to apply scientific methods.

The principal efforts of executives were devoted to store management involving new locations for stores, developing scientific sales methods, and the training of store personnel.

Competition became keener as more chains sprang into being in a territory; gross profits on sales were reduced, operating expenses in the stores, the principal items of which were store rent and store labor, became more or less fixed; and thus it became necessary in order to maintain a suitable net profit to look to other departments of the business for economies.

Of the items that go to make up the general overhead of the chains, among the largest are those of warehouse operation and transportation. In the past five or six years the more progressive chains have given much thought and study to the possibilities of effecting economies in these two operations, principally to that of warehousing.

Engineers have been employed, warehouses scientifically planned, labor-saving machinery introduced, and greater economies obtained.

OIL AND GAS POWER

SIMPLE METHOD FOR THE CALCULATION OF NATURAL FREQUENCIES OF TORSIONAL VIBRATION. By Frederic P. Porter, Fairbanks, Morse and Company, Beloit, Wis.

The calculation of the torsional-vibration characteristics of the shafting of reciprocating-engine installations is generally considered a laborious undertaking. This paper presents a method for calculating the natural frequencies of the shafting that is relatively simple in its application and yet retains the accuracy of the longer methods. This simplification is obtained by the proper choice of the equivalent system for mathematical treatment and by the use of tables and charts. The accuracy of the results has been compared with that of the results of other investigators.

SOME FEATURES OF THE LONG-DISTANCE TRANSPORTATION OF NATURAL GAS. By George I. Rhodes and Edgar G. Hill, Vice-President, Ford, Bacon, and Davis, New York, N. Y.

Increase from about 200-mile to 1000-mile pipe lines is a fair measure of the past five years' progress in the long-distance transportation of natural gas. This progress has been made economically possible in the transportation of large volumes of gas at high load factors largely as a result of pipe of higher strength and better quality than formerly available. The higher pressure coming into use is of only indirect benefit through effective utilization of the improved pipe. There has been no corresponding improvement in the compressing stations necessary on long lines.

Large high-pressure lines are now commonly laid with extra-long joints of pipe made up by welding from shorter joints and coupled together with improved rubber-packed couplings of the Dresser type. Welded joints are now stronger, cheaper, and more quickly made than formerly. Dresser-type couplings are now made to design data secured from careful test.

Valves formerly in use were not very satisfactory and higher pressure points to valves such as those used in superheated-steam practice. Valves of restricted diameter are frequently used with venturi nipples for connection into the lines of larger diameter. Further progress may result from further improvement in pipe, better methods of compression, and other developments now only "idle dreams."

PETROLEUM

CRANE LUBRICATION. By Eustis H. Thompson, Research Department, Baltimore Copper Smelting and Rolling Company, Baltimore, Md.

The crane equipment of a large copper-refining plant had been giving undesirable delays in a period of increased production. It

was found that lubrication troubles were frequent causes. These were overcome as described. In addition, some maintenance costs were greatly reduced by changes in lubrication of motor brakes and bearings.

The plan of preventing bearing losses, due to lack of lubrication as it was worked out at the plant, had an important bearing on the final result. The lubricants and lubricating devices which have finally been standardized along certain lines are described, and reasons for the steps involved are given.

THE WORK FACTOR OF LUBRICATING OIL. By James G. O'Neill, Chief Chemist, U. S. Naval Engineering Experiment Station, Annapolis, Md.

The usefulness of the standard laboratory tests in judging the quality of lubricating oils in the past has been limited, due to widely different crudes from which lubricating oils are produced and to the varied processes used in their refinement. The new method proposed for evaluating lubricating oils seeks to extend the application of the standard laboratory tests in that their results will indicate the service that will be obtained from the oils in actual operation. Increases in viscosity, neutralization number, precipitation number, and per cent of carbon residue of a lubricating oil when subjected to an endurance test, which simulates service conditions as found in a forced-feed lubrication system, are expressed numerically by means of formulas, and the average of these results is called the work factor of the oil. A description of the method and apparatus of the endurance test is given, and the concordance of results obtained is shown when different machines are used to test the same oil. The work factors of turbine, Diesel-engine, and aviation oils are discussed with relation to their performance in actual service. The Navy method for purchase of lubricating oils, is discussed, as also are the advantages derived from the use of the work factor.

EVALUATION OF STEAM-TURBINE-OIL STABILITY. By C. M. Larson, Supervising Engineer, Sinclair Refining Company, New York, N. Y.

The Navy work-factor method, although sufficient in itself to indicate the rate of decomposition, loss through evaporation, and the corrosive tendencies in steam-turbine oils, fails to measure definitely the resistance to emulsion. The demulsibility at 130 deg. fahr. of samples taken every 25 hr. during the 100-hr. Navy work-factor run, however, records the emulsion tendencies, and this demulsibility change is a measure of stability of steam-turbine oils.

LUBRICATION OF TEXTILE MACHINERY. By L. A. Baudoin, Assistant Supervising Engineer, Sinclair Refining Company, New York N. Y.

Cotton textiles require absolute cleanliness during manufacture and finishing, and all operations, including the lubrication of the equipment, assume a secondary status. Present design incorporates modern developments aiding lubrication, also providing reserve lubricant and ample protection to fabric. Frequent minimum application is accepted practice, but "freak" oils are not necessary. A table indicates frequency of application, cleaning period, and product required.

PRINTING INDUSTRIES

DESIGN OF MILLER SIMPLEX AUTOMATIC TWO-REVOLUTION CYLINDER PRESS. By A. W. Barrett, Vice-President in Charge of Engineering, Miller Printing Machinery Co., Pittsburgh, Pa.

Among flat-bed cylinder presses, the Simplex has a sheet-feeding mechanism that does not employ moving tapes and rollers; the bed and the impression cylinder, carrying the form and the paper, respectively, are held in synchronism by a rack; ink distribution is obtained by a rotary-press type of vibrating ink drum; the sheet-delivery tapes are driven at a set speed by a separate motor; a safety gripper tumbler prevents starting the press when the grippers are up.

SOME PROBLEMS IN STANDARDIZATION. By Fred S. English, Chief Engineer, Babcock Printing Press Manufacturing Company, New London, Conn.

Lack of standardization of certain factors which enter into the design and use of cylinder printing presses is discussed in a general manner, particularly relative to the standardization of plates and bases, diameters of cylinders, depth of impression surface below cylinder bearers, height of bed bearers, sheets, forms, and names of parts.

DESIGN OF THE NEW HARRIS AUTOMATIC TWO-COLOR FLAT-BED PRESS. By Alfred S. Harris, Cleveland, Ohio.

A recent design of two presses, one a single-color and the other a two-color press, includes the standardization of parts and units to such an extent that 72 per cent of these parts are common to both presses. A few of the points described in the design are those contributing to rigidity of frame, impressional strength, uniformity of bed travel during the printing stroke, evenness of ink distribution, and accuracy of register. Accessibility to its adjustments and convenience for make-ready also receive attention.

SIZES AND TOLERANCES FOR METAL FITS—ADVANTAGES OF STANDARDIZATION FOR MANUFACTURING PRACTICE. Controlling Influences and Application to Existing Conditions—Analysis and Reference to the Practice in Other Plants. By C. R. Reiman, Special Investigator, Kelly Press Division, American Type Founders Co., Elizabeth, N. J.

This paper discusses in a detailed and graphical manner comparisons of metal fits. In many plants the matter of working fits is left largely to the opinion and ability of the workman, and the need for standardization in consequence asserts itself, as organizations are entitled to records of these matters.

The comparisons of the practice governing other standards and the analysis that influences the author's conclusions are given in a simple way. Simplification for better understanding is aimed at, and the need for a standard common practice throughout the industry is recognized. Controlling influences are considered, and various features for which advantages are claimed are stressed. The use of the basic-size-to-under hole system and the basic shaft are discussed. Different kinds of fits are compared, and the reasons for differentiating between straight shafts and turned studs are given.

FORCES IN CONNECTION WITH THE RECIPROCATING BEDS OF FLAT BED CYLINDER PRINTING PRESSES. By B. D. Stevens, and H. E. Golber, respectively, First Vice-President, and Research Engineer, Miehle Printing Press and Manufacturing Company, Chicago, Ill.

This article deals with printing-press beds, their mechanisms, and forces. The mechanisms of some well-known presses are described sufficiently to show that the dynamic problems are identical for all. The forces are examined as to their effect upon the motor, the machine, and the building. Reference is made to certain methods which have been tried for reducing or counterbalancing them, and some criticisms and suggestions are made.

RAILROADS

HIGH-PRESSURE AND HIGH-TEMPERATURE STEAM. By C. F. Hirshfeld, Chief, Research Department, Detroit Edison Company, Detroit, Mich.

The author states his position as that of giving to railroad men the benefit of experience had in stationary steam-power-plant practice and not as that of telling them what to do in locomotive practice. The advantages of high pressures and temperatures in stationary practice are considered separately for condensing operation and for back-pressure operation, respectively, and the differences are stressed. Certain experiences and observations regarding the behavior of metals and the boiler circulation under extreme conditions are given, and these are followed by speculations regarding the possible lines of development of locomotives.

RESEARCH RELATING TO THE ACTION OF 4-WHEEL FREIGHT-CAR TRUCKS. By T. H. Symington, Executive head, T. H. Symington & Son, Inc., Baltimore, Md.

This paper includes a study of operating and maintenance problems of car trucks that have resulted from increased weights, greater rigidity, and high speeds. The author discusses the 4-wheel truck as a whole, and includes such features of design as cross-equalization, swiveling resistance, self-squaring, car roll and nosing, guard-rail shocks, lateral motion, and four-point suspension.

Harmonic truck-spring action is discussed at considerable length. It is felt that excessive harmonic spring oscillation at critical train speeds may be caused by eccentricity of wheels. Tests will be made to determine this, and the author outlines various tests for determining unknown factors.

TEXTILES

SPECIAL APPLICATIONS OF ELECTRIC MOTORS IN CLOTH-FINISHING PLANTS. By A. M. MacCutcheon, Engineering Vice-President, Reliance Electric & Engineering Company, Cleveland, Ohio.

In cloth-finishing plants, it is frequently desired to operate several machines in approximate synchronism, each machine being driven by an individual motor. It is then necessary to introduce between the various units of the train or range a compensating device to secure the approximate synchronism necessary for successful operation. The device most commonly used in the finishing plants is a "dancer-roll." In such a group of motors there are two classes of speed changes to be accomplished. The main change in speed is desired for the handling of different types and weights of fabrics, and this main change in speed must be common to each one of the group of motors operating in the range. A secondary speed change, individual with respect to each particular motor and necessary to keep the individual motor in synchronism with the other motors in the range, is also required. If both the main and secondary speed changes be accomplished by means of field control, the one is superimposed on the other, with results not as successful as though the two classes of speed change are separated, one secured by voltage control and the other by field control. Obvious with this advantage is the necessity for a control set supplying voltage to each group of motors which has a common main-speed change. The advantages, on the other hand, are the simplicity of control, the wide range of speed changes which may be secured, and the unusual smoothness of operation. The method of securing the main change in speed by the use of voltage control has been known in the cloth-finishing plants of the country for many years, but until recently its advantages have not been clearly recognized, whereas they were many.

WOOD INDUSTRIES

DUST EXPLOSIONS, WITH SPECIAL REFERENCE TO WOODWORKING INDUSTRIES. By Hylton R. Brown, Engineer, Chemical Engineering Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture, Washington, D. C.

Explosions in flour mills have been common, but now the hazard is recognized in grain elevators, starch factories, sugar refineries, woodworking plants, textile mills, and other factories in which materials in the form of dust are manufactured. The woodworking industry is considered susceptible to this danger, especially since there is created a great quantity of dust from saws, planers, and sanders, and the recent manufacture of wood flour. More than thirty explosions in woodworking plants have been investigated. These indicate that wood dust is more easily ignited than some of the grain dusts. Precautionary measures are suggested.

RESEARCH IN WOOD PRODUCTS. By James W. Lawrie, A. O. Smith Corporation, Milwaukee, Wis.

Wood has widely different characteristics, and species may be chosen for a wide range of industrial and construction purposes possessing either high strength-weight ratios or qualities that permit cutting thin veneers also possessing great ultimate strength or low specific gravity. It varies widely in color, grain structure, and beauty. Wood also has faults and limitations which can be largely corrected through intensive research. Wood expands when wet. Research with the X-ray has shown the reason, and has pointed to a way of rendering wood nearly non-expansive. Wood can be made fire-resistant. Preventive measures can be taken to lengthen the life of wood by toxic-chemical treatments to eliminate decay. Wood-finishing methods can be greatly improved by scientific adaption of the right principles.

Form for Ordering Advance Copies of 1930 A.S.M.E. Annual Meeting Papers

NOTE: The Papers listed by number on page 1020, to be presented at the A.S.M.E. Annual Meeting, December 1–5, 1930, will be available in pamphlet form and may be secured without cost by any member of the Society.

Check numbers in request below and mail to Secretary, A.S.M.E., 29 West 39th St., New York, N. Y.

Order Number		Reserved for Date Stamp
Written		
Date	By	

TO THE SECRETARY, A.S.M.E., 29 West 39th Street, New York City Date.....

Please send copies of papers Nos. [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14]

[15] [16] [17] [18] [19] [20] [21] [22] [23] [24] [25] [26] [27] [28]

[29] [30] [31] [32] [33] [34] [35] [36] [37] [38] [39] [40] [41] [42]

[43] [44] [45] [46] [47] [48] [49] [50] [51] [52] [53] [54] [55] [56]

[57] [58] [59] [60] [61]

PRINT Name (Important).....

Street Address ..... City .....

Current Mechanical Engineering Literature

Selected References From The Engineering Index Service

(The Engineering Index Service Is Registered in the United States, Great Britain, and Canada by the A.S.M.E.)

THE ENGINEERING INDEX SERVICE furnishes to its subscribers a Weekly Card Index of references to the periodical literature of the world covering every phase of engineering activity, including Aeronautic, Chemical, Civil, Electrical, Management, Mechanical, Mining and Metallurgical, Naval and Marine, Railway, etc. Of the many items of particular interest to mechanical engineers a few are selected for presentation each month in this section of "Mechanical Engineering." In operating The Engineering Index Service, The American Society of Mechanical Engineers makes available the information contained in the more than 1800 technical publications received by the Engineering Societies Library (New York), thus bringing the great resources of that library to the entire engineering profession. At the end of the year all references issued by the Service are published in book form, this annual volume being known as The Engineering Index.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

AIR CONDITIONING

Air-Expansion Process. Cooling and Drying Air (Air Conditioning) With Particular Reference to the Air Expansion Process, A. Baumann. Brown Boveri Rev., vol. 17, no. 9, Sept. 1930, pp. 271–282, 14 figs. In private, public, and industrial buildings, direct cooling of air by cold-air machine is to be preferred for hygienic, technical, and economic reasons to vapor-compression machine; principles of systems are reviewed; Brown Boveri and Co. were pioneers in application of turbo-compressor in refrigerating plants with vapor-compression machines, and have recently built cold-air machine on turbo principle for gold mines in South Africa; Mollier chart for moist air used for changes in air condition.

AIR PREHEATERS

Control. Control and Safety Devices for Air-Preheater Installations (Regelungs und Sicherheitseinrichtungen an Lufterhitzeranlagen), Harraeus. Feuerungstechnik (Leipzig), vol. 18, no. 13–14, July 15, 1930, pp. 135–138, 13 figs. Devices for regulation of superheated-air temperature; guide channels for flue gases; turning on and off of different air-heated elements; admixture of hot gases or cold air; safety devices against burning of protective elements; cooling of heating gases; coupling of air blower with governing valves for admission or discharge of heating agent.

AIRPLANE ENGINES

Air-Cooled. 1000-Hp. Air-Cooled Engine Will Power Future Aircraft, A. H. R. Fedden. Automotive Industries, vol. 63, no. 9, Aug. 1930, pp. 307–308. Brief review of various types of modern air-cooled engines; notes on supercharging and cowling; future possibilities, particularly of oil engine are outlined. Read before Brit. Inst. Mech. Engrs.

Design. Factors Involved in Developing Light Weight Design, E. A. Ryder. Machine Design, vol. 2. no. 7, July 1930, pp. 15–19, 7 figs. Discussion of salient features of light-weight design in Pratt and Whitney engines; physical properties of various materials used in design; table gives specific strength of common materials used in aircraft-engine design.

Reduction Gears. Airplane Engines With Automatically Variable Reduction Gear (Motore di aviazione con demoltiplicatore automaticamente variabile). Ala d'Italia (Milan), vol. 11, no. 8, Aug. 1930, pp. 669–670, 5 figs. Description of 4-cylinder four-cycle experimental rotary engine with pistons acting on individual crankshafts provided with pinions which in turn engage centrally located gear arrangement; sketches and diagrams show principal details; with decreasing air resistance, propeller speed automatically increases, output of engine remaining constant.

Testing. Engine Performance at High Altitudes Studied by the Bureau of Standards, P. M. Heldt. Automotive Industries, vol. 63, no. 8, Aug. 23, 1930, pp. 256–258 and 263, 5 figs. Description of testing facilities for investigations on superchargers, lubricating oils, flame propagation in engine cylinders, effect of humidity on engine operation, ignition phenomena, and combustion at constant pressure; flying heights are simulated by decreasing atmospheric pressure and lowering temperature.

AIRPLANES

Amphibian. The Saro Flying Cloud. Flight (London), vol. 22, no. 30, July 25, 1930, pp. 831–832 2 figs. Description of amphibian boat design similar to Cutty Sark and equipped with two Whirlwind engines; length o.a. 47 ft. 9 in.; pay load 1420 lb.; maximum speed at sea level 120 m.p.h.; landing speed 55 m.p.h.

Ice-Formation Prevention. The Prevention of the Ice Hazard on Airplanes, W. C. Geer and M. Scott. Nat. Advisory Committee for Aeronautics—Tech. Note, no. 345, July 1930, 23 pp., 11 figs. Discussion of factors controlling ice formation and outline of possible means of preventing ice; laboratory work done at Cornell University, Ithaca; description of ice-removing overshoe consisting of rubber treated with special oil mixture; inflation by means of compressed air breaks ice on leading edges provided with overshoe.

Performance Calculation. A Proof of the Theorem Regarding the Distribution of Lift Over the Span for Minimum Induced Drag, W. F. Durand. Nat. Advisory Committee for Aeronautics—Report No. 349, 13 pp. 8 figs. It is shown mathematically that elliptical distribution across span gives minimum value of induced drag.

Advance Calculation of Altitude Performance (Die Vorausberechnung der Hoehenleistungen), O. Schwager. Flugwesen (Prague), vol. 10, no. 6, 1930, pp. 61–63, 3 figs. Brief discussion of various formulas and comparison with results of test flights.

How Fast Is Maximum Speed? E. G. Reid. Aviation, vol. 29, no. 2, Aug. 1930, pp. 86–91, 11 figs. Outline of simplified methods for calculating maximum speed and comparison of advertised figures for group of commercial planes with figures obtained by actual test for group of typical service planes.

Propellers, Variable-Pitch. Gloster-Hele-Shaw-Beacham Variable-Pitch Airscrew. Machy. (Lond.), vol. 36, no. 931, Aug. 14, 1930, pp. 636–638, 3 figs. Adaptation of this type to requirements of engine; sensitiveness to any change in r.p.m. of engine diagram of variable-pitch gear.

Spinning Characteristics. Dangerous Flat Spin and Its Control (Der gefaehrliche flache Trudelflug und seine Beeinflussung), R. Fuchs, and W. Schmidt. Zeit. fuer Flugtechnik und Motorluftschiffahrt (Munich), vol. 21, nos. 13 and 14, July 14, 1930, pp. 325–333 and July 28, 1930, pp. 359–364, 26 figs. Mathematical investigation of flat-spin phenomena and calculation of forces based on wind-tunnel test; constructive measures for prevention of flat spins are discussed. Bibliography.

Stress Analysis. Calculation of Resistance and Static Tests (Calculs de resistance et essais statiques), L. Kirste. Aéronautique (Paris), vol. 12, no. 134, July 1930, pp. 251–252, 1 fig. Outline of standard methods used in France, Germany, United States, England, and Italy for calculating stresses in various types of airplanes under different flying conditions; brief discussion of tests on elasticity, breakdown, and resistance against repeated stresses.

Welded Joints. Metal Joints in Aircraft Construction, T. W. Downes. Welding, vol. 1 no. 10, Aug. 1930, pp. 563–667, 7 figs. Discussion of technique in making joints by each of methods of welding, brazing, and soldering by different welding processes; data on composition of fluxes and strength of welded joints. Abstract of paper presented before Am. Soc. Testing Matls., June 23, 1930.

Strength of Welded Joints in Tubular Members for Aircraft, H. L. Whitteman and W. C. Brueggeman. Nat. Advisory Committee for Aeronautics—Report, no. 348, 1930, pp. 5–41, 31 figs. Investigation on strength, weight, and cost of number of types of welded joints; 40 joints were welded under procedure specifications and tested to determine their strengths; weight and time required to fabricate each joint.

Wings, Air Flow About. Investigation of the Variations in the Velocity of the Air Flow About a Wing Profile, W. Repenthin. Nat Advisory Committee for Aeronautics—Tech Memorandum, no. 575, July 1930, 18 pp., 7 figs Determination of velocity as compared with that of undisturbed flow and of velocity drop in successive planes perpendicular to flow direction at increasing distances from wing profile; approximate picture of asymmetry of loading of propeller disk at different positions of propeller with respect to wing profile. Translated from Zeit. fuer Flugtechnik u. Motorluftschiffahrt, July 15, 1929.

Wings, Slotted. Practical Experiences With Slotted Wings of Automatic Type (Praktische Erfahrungen mit dam automatischen Spaltflugel), G. Lachmann. Zeit. fuer Flugtechnik und Motorluftschiffahrt (Munich), vol. 21, no. 16, Aug. 28, 1930, pp. 409–419. Description and aerodynamics features of slotted wings and effect on airplane performance; sketches show mechanism of automatic operation.

AIRSHIPS

Pressure Distribution. Calculation of Pressure Distribution on Airship Hulls, T. Von Karman. Nat. Advisory Committee for Aeronautics—Tech. Memorandum, no. 574, July

1930, 27 pp., 9 figs. Mathematical analysis of air-flow conditions and pressure distribution based on shape of ZR 111, with following simplifications: cars, fins, and rudders removed; all cross-sections replaced by equivalent circular cross-sections; calculations are made for symmetrical case, of flow parallel to axis; unsymmetrical case, or flow at angle to axis.

ALLOYS

Aluminum. See ALUMINUM ALLOYS.

Brass. See BRASS CASTINGS.

Copper. See COPPER ALLOYS.

Heat-Resisting. Behavior of Heat-Resisting Alloys in Presence of Sulphur and a New Sulphur-Resistant Alloy (Der Verhalten hitzebestaendiger Legierungen gegen Schwefel und eine neue schwefelbestaendige Legierung), H. Gruber. Stahl und Eisen (Duesseldorf), vol. 50, no. 36, Sept. 4, 1930, p. 1272. Increase of resistance against attack of sulphur compounds by means of aluminum addition (alloy no. 8) is attributed to increase in melting point of sulphide-layer formation and to formation of very thin but gas-impervious skin of aluminum oxide. Abstract from Wilhelm Heraeus 70th Birthday special volume.

ALUMINUM

Sheet, Bending Test for. The Bending Test for Aluminum Sheet. Metal Industry (Lond.), vol. 37, no. 9, Aug. 29, 1930, pp. 193–195. Scientific application of what used to be considered rough and ready test for selection of aluminum sheet of correct temper for different purposes; American system of grading aluminum sheets according to temper and its comparison with British system.

ALUMINUM ALLOYS

Castings, Heat Treatment of. Aluminum Alloys for Heat-Treated Castings, R. J. Anderson. Metallurgia (Manchester), vol. 2, no. 10, Aug. 1930, pp. 129–132 and 154, 4 figs. Bulk of present commercial requirements for heat-treated castings can readily be met with relatively few compositions; enumeration and discussion of chief alloys that have been or are used in practice; microstructure as affected by heat treatment; effect of heat treatment on mechanical properties; uses of heat-treated castings.

AUTOMOBILE ENGINES

Ignition. Graham-Paige Develops Spark Plug Designed to Eliminate Preignition, F. F. Kishline. Automotive Industries, vol. 63, no. 11, Sept. 13, 1930, pp. 376–378, 4 figs. Increased shell thickness and longer center insulator adopted after research indicates possibilities of high compression ratios because of ability to withstand top-speed operation without cold-weather fouling troubles.

Supercharging. Supercharging of Internal-Combustion Engine (La suralimentation des moteurs a combustion Interne), C. Martinot-Lagarde. Technique Moderne (Paris), vol. 22, nos. 14 and 15, July 15, 1930, pp. 489–496 and Aug. 1, 1930, pp. 535–537, 23 figs. July 15: Discussion of fundamentals of supercharging and review of principal designs of superchargers; details on Rateau exhaust driven, and Rateau Farman variably geared superchargers; graphs give performance data for both types. Aug. 22: Notes on supercharging of Diesel engines.

The Zoller Supercharger. Autocar (Lond.), vol. 65, no. 1811, July 18, 1930, pp. 130, 4 figs. Notes on design of supercharger driven from crankshaft; mechanical silence is obtained by elimination of gears; sketches show arrangement of blades; output for various sizes varying from 500 to 5000 ft. deep per revolution for speeds up to 6000 r.p.m.

AUTOMOBILES

Axles. Front Axle Design, R. Dean-Averns. Automobile Engr. (Lond.), vol. 20, no. 270, Aug. 1930, pp. 299–302, 7 figs. Detailed survey of problems involved in calculating dimensions and stresses for front axles; discussion of vibrations and critical speeds.

Universal Joints. Kinematics of Universal Joints (Die Bewegungsverhaeltnisse bei Kardangelenken), W. Reinecke. Automobiltechnische Zeit. (Berlin), vol. 33, no. 22, Aug. 10, 1930, pp. 530–534, 20 figs. Mathematical investigation of forces and velocity; acceleration and degree of non-uniformity graphs illustrate that power transmission at angles of more than 45 deg. becomes very uneconomical.

AUTOMOTIVE FUELS

Anti-Knock Compounds. Detonation and Lubricating Oil, R. O. King and H. Moss. Engineering (Lond.), vol. 130, no. 3367, July 25, 1930, pp. 99–101. Review of experimental results; effect of lubricating oil on detonation in practice; effect of lubricating oil and air temperature on matching of fuels of dissimilar composition; application of experimental results to engine lubrication; dispersion and distribution of oil; supercharged engines.

The Use of Water as an Anti-Detonant, G. W. Hobbs and M. L. Fast. Mich. Eng. Experiment Sta.—Bul., no. 31, vol. 1, no. 4, July 1930, 15 pp., 7 figs. Investigation to determine value of water as anti-detonant, and its effect upon actual engine, and ideal cycle, effect of compression ratio upon power efficiency, and air-gas ratio.

Detonation. Methods of Measuring the Anti-Knock Value of Fuels for Internal-Combustion Engines, D. B. Brooks. Motive Power, vol. 1, no. 7, Aug. 1930, pp. 17 and 34. For past two years, Bureau of Standards has been cooperating with seven other laboratories, representing automotive and petroleum industries; program of tests designed primarily to show how well group of laboratories would agree in rating same set of fuels if they used identical equipment and followed same instructions; description of experimental engine. Paper read before Petroleum Technologists of Nat. Petroleum Assn., Washington, D. C.

B

BALANCING MACHINES

Theory and Design. Machine for Dynamical Balancing of Rotating Masses (Les machines a équilibrer dynamiquement les pièces tourantes), G. Delanghe. Génie Civil (Paris), vol. 97, no. 8, Aug. 23, 1930, pp. 176–179, 6 figs. Discussion of theory and design of machines built by Mitsubishi; sketches show vibrating bearing of Westinghouse machine.

BLAST FURNACES

Design. Technical Progress in Design of High-Capacity Blast Furnaces (Progres techniques réalisés dans la construction des hauts fourneaux à grande production), M. Derclaye. Revue Universelle des Mines (Liége), vol. 4, nos. 3 and 4, Aug. 1, 1930, pp. 71–80 and Aug. 15, pp. 106–116, 24 figs. Aug. 1: Notes on hearth jackets; mantle brackets, arrangement of columns around furnace; encircling of shaft. Aug. 15: Refractory brick; blast-furnace equipment, tuyeres, etc.; charging.

BOILERS

Corrosion. Formation and Properties of Boiler Scale, E. P. Partridge. University of Mich.—Dept. of Eng. Research—Bul., no. 15, June 1930, 170 pp., 21 figs. Complete review of information available up to year 1930 concerning formation and properties of boiler scale; effects of scale upon boiler efficiency and boiler metal temperature; chemical and crystallographic determination of scale constituents; respective solubilities of these constituents in simple solutions, and possibility of calculation equilibria in complex solutions; method and rate of formation of scale; contemporary methods of scale prevention.

Flue-Dust Removal. Steam Boilers as Flue Dust Separators (Dampfkessel als Flugaschenabscheider), W. Otte. Archiv. fuer Waermewirtschaft (Berlin), vol. 11, no. 8, Aug. 1930, pp. 261–268, 22 figs. Study was made to ascertain what structural means can be employed for flue-dust removal in boilers; gas conduction in combustion chamber and in boiler flues; arrangement of flue-dust collectors; criticism of some older types of inclined and vertical-tube boilers with regard to their adaptability as flue-dust collectors; new types.

Furnaces. Present Status of Boiler Furnaces (Ueberblick ueber den derzeitigen Stand der Dampfkesselfeuerungen), O. Nerfer. Zeit. des Bayerischen Revisions-Vereins (Munich), vol. 34, nos. 14 and 15, July 31, 1930, pp. 200–202 and Aug. 15, pp. 213–216. Brief discussion of different fuels and their properties during combustion, followed by notes on design of furnaces and stokers for their use.

Progress in Stoker and Furnace Construction and Results of Tests on Modern Furnaces (Ueber Fortschritte im Rost und Feuerungsbau und Versuchsergebnisse an modernen Feuerungen), R. Schulze. Brennstoff und Waermewirtschaft (Halle), vol. 12, nos. 13–14, July 1–2, 1930, pp. 168–174, 5 figs. By comparison of some entirely modern boiler installations with other 4 to 6 years old, it is shown to what extent modern stokers and furnaces are superior to older types.

High-Pressure, Fittings for. Fitting for Super-Pressure Boilers for 130 Atm. and 500 Deg. Cent. (Armaturen bei Hoechstdruckkesseln), Belohlavek. Waerme (Berlin), vol. 53, no. 28, July 12, 1930, pp. 544–547, 8 figs. Fittings described are employed in all Loeffler boilers and have given satisfaction over period of several years operation.

Lancashire. An Improved Lancashire Boiler. Mech. World (Lond.), vol. 88, no. 2279, Sept. 5, 1930, pp. 218–219, 2 figs. Improved Boiler by D. Adamson and Co. was described in this journal, Feb. 10, 1928; brick side flues were eliminated, being replaced by tubes; principle has been further developed in new installation; thermal efficiency by test was 83.24 per cent which compares with usual efficiencies of Lancashire boilers of 60 to 70 per cent; plant is much smaller, more compact, less costly in installation and upkeep, and no high chimney is required.

Water-Tube, Japanese. Development of Water Tube Boilers in Japan, M. Kamo. Far East. Rev. (Shanghai), vol. 26, no. 6, June 1930, pp. 310–312 and 317, 6 figs. General design features of Takuma boiler equipped with water tube 2½ in. external diameter and fitted to upper and lower drum in zig-zig fashion at inclination of 45 deg.; test results of boiler are given.

BRASS CASTINGS

Lead Content. Lead in Cast Brass and Bronze, H. C. Dews. Metallurgia (Manchester), vol. 2, no. 9, July 1930, pp. 81–83, 2 figs. Suspicion as to bad effect of lead in brass and bronze is reflected in specifications; insolubility of lead in brass and bronze makes it liable to segregation and liquation, both in liquid melt and during freezing of alloy; effect of lead on mechanical properties of brass and bronze; main reason for allowing addition of lead to brass and bronze is that improvement in machinability is gained.

C

CARBON DIOXIDE

Solid, Production of. New Method of Solid Carbon Dioxide Production. Cold Storage (Lond.), vol. 33, no. 389, Aug. 21, 1930, pp. 243–244, 2 figs. Description of "Carba" process, which represents advance of former methods in that ice is compressed as it forms, without exposure to atmosphere and without employment of hydraulic or mechanically operated presses; practical difficulties in application of theory.

Thermal Properties. A Characteristic Chart for Solid, Liquid, and Gaseous Carbon Dioxide. Refrig. Eng., vol. 20, no. 1, July 1930, p. 33, 2 charts on supp. plates. Two page Mollier diagram for carbon dioxide is illustrated and explained; table of physical properties of carbon dioxide is also given.

CARS

Freight. Performance of 100-ton Car With Four-Wheel Trucks. Ry. Age, vol. 89, no. 7, Aug. 16, 1930, pp. 331–332, 3 figs. Brief description of experimental car, built by Pressed Steel Car Co. in 1921 which is in good condition after eight years of service.

Retarders. Froelich Hydraulic Car Retarder System. Ry. Signaling, vol. 23, no. 9, Sept. 1930, pp. 329–334, 8 figs. Discussion of design and operating characteristics of system, which is first classification yard in Great Britain to be equipped with Froelich system of hydraulic car retarders, involving semi-automatic switch control and number of other salient features; diagram of hydraulic and braking systems is illustrated; mechanical and electrical apparatus.

CASE HARDENING

Cyanide Bath. Hardening Steel Commercially by Cyaniding Process, E. F. Davis. Steel, vol. 87, nos. 3, 5, and 7, July 17, 1930, pp. 43–46 and 60, July 31, pp. 47–48 and 53. Aug. 14, pp. 48, 50, and 52, 17 figs. July 17: Outline of history of cyanide, properties and advantages of various grades, and mechanism of hardening process. July 31: Discussion of brittleness of cyanided steels and its relation to cyaniding temperature and quenching methods, cyaniding gears and wire; various advantages and disadvantages of cyaniding as a hardening process. Aug. 14: Description of furnaces and pots for cyaniding, aerocase method, fume prevention, cyanide poisoning, and testing cyanide baths.

CAST IRON

Chilling Properties. Factors Affecting the Chilling Properties of Cast Iron, A. L. Norbury. Foundry Trade Jl. (Lond.), vol. 43, no. 726, July 17, 1930, pp. 44–45, 7 figs. Results are given which illustrate differences in chilling properties that may be obtained from irons of same chemical analysis, while other results illustrate sulphur contents, and mold temperatures on chilling properties. Paper presented on behalf of Inst. of Brit. Foundrymen to Pan-European Foundry Congress, Liege, June 1930.

Hardness Testing. The 139-Degree Pyramid Hardness Test on Cast Iron, A. L. Norbury. Brit. Cast Iron Research Assn.—Bul. (Birmingham), no. 29, July 1930, pp. 271–274, 4 figs. Comparison of hardness tests on gray cast iron using 10 mm. Brinell ball and 136-deg. pyramid; effect of size of impression on variations between repeat hardness tests or gray cast iron.

Machinability. Machinability of Cast Iron, E. J. Lowry. Am. Soc. Testing Matls.—Proc., part 2, vol. 29, 1929, pp. 126–127. Paper discusses factors which influence machinability; although machinability of cast iron is function of abrasion, hardness, and ductility, hardness alone cannot be considered as true indicator of machineability since it does not measure abrasive quality of metal; and influence which tends to eliminate abrasiveness increases machineability; such as annealing, higher silicon content, higher carbon content, or addition of nickel, titanium, or any other softening alloy.

CASTINGS

Shrinkage. Shrinkage of Metals and Alloys (Ueber die Schwindung der Metalle und Legierungen), F. Sauerwald. Giesserei (Dusseldorf), vol. 17, no. 33, Aug. 15, 1930, pp. 793–795, 5 figs. Shrinkage in its relation to expansion coefficient and nature of solidification process is discussed.

CLUTCHES

Design. Design of Clutches for Internal-Combustion Engines, W. J. Pearmain. Motive Power, vol. 1, no. 6, July 1930, pp. 16–19, 8 figs. Factors of design of spring-loaded clutches; formulas are given for clutch-size determination; practical problems are included.

COAL ASH

Softening Point. Softening of Ash of Solid Fuel (Over de verweeking van de asch van vaste brandstof), H. A. J. Pieters. Chemisch Weekblad (Amsterdam), vol. 27, no. 22, May 31, 1930, pp. 331–334, 4 figs. Modified apparatus for determining softening point of ash and results obtained with it; three classes are distinguished with softening temperatures, respectively, below 1250 and above 1250 deg., third class showing softening but not melting above 1250 deg.; relationship between softening temperature and chemical composition.

COMPRESSORS

Gas. A Seven-Stage Gas Compressor. Engineer (Lond.), vol. 150, no. 3890, Aug. 1, 1930, pp. 118–119, 7 figs. partly on p. 120. Fundamental characteristic of Sulzer hyper-compressor is vertical arrangement of cylinders for sixth and seventh stages; these cylinders are operated hydraulically by means of columns of oil; machine supplied to Compagnie de Bethune, Bully-les-Mines, is designed to deal with effective suction intake of 4000 to 4500 cu. m. per hr. at final pressure of 1000 to 1100 atmospheres.

COPPER ALLOYS

Copper-Silicon. Silicon-Copper Alloys and Silicon Manganese-Copper Alloys, E. Voce. Inst. of Metals—Advance Paper (Lond.), no. 543, for mtg. Sept. 9–12, 1930, 31 pp., 16 figs. Survey of alloys, studying their mechanical and physical properties in cast, drawn, and rolled conditions, with view to developing and extending their uses; their resistance to corrosion has received attention, especially in light of development in America of alloys of copper with silicon and manganese in connection with chemical plant.

A New Silicon-Zinc-Copper Alloy, E. Vaders. Inst. of Metals—Advance Paper (Lond.), no. 544, for mtg. Sept. 9–12, 1930, 17 pp., 17 figs). Use of silicon as deoxidizer and as alloying constituent in some copper alloys; preparation of silicon-zinc-copper alloys containing 70–90 per cent of copper and up to 6 per cent of silicon-zinc-copper alloys; mechanical and physical properties and uses of these alloys.

CORE OVENS

Gas-Fired. Continuous Oven Reduces Core Losses, J. B. Nealey. Foundry, vol. 58, no. 16, Aug. 15, 1930, pp. 58–60, 4 figs. Description of design and operation of counterflow, heat sealed, indirect heated, gas-fired, two-compartment, continuous-type core oven to bake crankcase cores, installed at plant of Studebaker Corp., South Bend, Ind.; oven was made by Swartwout oven division of Foundry Equipment Co., Cleveland, and heating unit was supplied by Drying Systems, Inc., Chicago; weight of material handled, including racks, conveyor, and cores is 50,000 lb. per hr.

CRANES

Control. Energy Required for Stopping of Cranes With Swinging Load (Erforderlig tarbete for bromsning av kranar med pendlande upphangning av lasten), J. Bjorklund. Teknisk Tidskrift (Stockholm), vol. 60, no. 33, Aug. 16, 1930 (Mekanik), pp. 97–112, 22 figs. Studies of cranes with swinging loads show that braking power needed usually is less and sometimes considerably less than combined kinetic energies of crane and load; method used and formulas derived are compared with Lagrange's equations and are shown to be sufficiently exact for practical purposes.

Design. Crane Runway Columns Reviewed, R. Fleming. Eng. News-Rec., vol. 105, no. 10, Sept. 4, 1930, pp. 369–370, 2 figs. General discussion of design of heavy-duty steel cranes; bending-moment diagrams for crane columns; brackets are unsatisfactory for loads over 10 tons.

CUTTING TOOLS

Standardization. Use of Standardized Tools in Shop Practice (Verwendung genormter Werkzeuge in der Praxis), V. Jereczek. Maschinenbau (Berlin), vol. 9, no. 15, Aug. 7, 1930, pp. 497–501, 27 figs. Discussion of proper use of various types of spiral drills and gear cutters; damages due to improper treatment are illustrated.

Testing. Testing of Cutting Properties by Means of Leyensetter Pendulum (Die Pruefung der Zerspanbarkeit mittels des Leyensetter-Pendels), A. Wallich and K. Krekeler. Archiv. fuer das Eisenhuettenwesen (Dusseldorf), vol. 4, no. 1, July 1930, pp. 41–43, 8 figs. Purpose and application of pendulum developed by W. Leyensetter are explained; some counter-pressure cutting speed curves are given which demonstrate cutting characteristics of material.

Tungsten Carbide. Carboloy Tool Applications at the Haughton Elevator and Machine Co., C. W. Bennett. Carboloy, vol. 2, no. 6, Aug. 1930, pp. 2–5, 4 figs. Notes on application of carboloy tools at plant at Toledo, Ohio, for turning of cast iron and semi-steel; data on drilling slate with carboloy flat drill.

Vibrations. Vibration Friend— or Enemy— C. B. Lord. Am. Mach., vol. 73, no. 10, Sept. 4, 1930, pp. 381–382, 2 figs. Discussion of methods of utilizing vibration phenomena in operation of cutting tools.

D

DIE CASTING

Dies for. Correct Design and Heat Treatment of Steel Dies for Die Castings, R. L. Johnson. Iron Age, vol. 546–548 and 576. Discussion of important points of mechanical design; chemical composition and heat treatment of alloy-steel dies; die life is from 15,000 to 200,000 castings.

Practice. Influence of Casting Practice on Physical Properties of Die Casting, C. Pack. Am. Inst. Min. and Met. Engrs.—Tech. Pub., no. 346, for mtg. Sept. 1930, 14 pp., 7 figs. Outline of some factors in commercial die-casting practice, to which variations in physical properties may be attributed.

Modern Die-Casting Practice, E. V. Pannell. Engineer (London), vol. 150, nos. 3892 and 3893, Aug. 15, 1930, pp. 168–169, and Aug. 22, pp. 193–194, 2 figs. Aug. 15: Survey of present status of art of casting non-ferrous metals by pressure; modern factory devoted to production of die casting will consist mainly of five departments: (1) metal melting, (2) die casting, (3) trimming, (4) enameling and plating, (5) die making, die-casting machines. Aug. 22: Steel molds or dies used in die-casting industry; metals and alloys.

Pressure Castings. Compressed Metals (Les Métaux comprimés), G. Batta and J. Dessent. Revue Universelle des Mines (Liege), vol. 73, no. 5, Mar. 1, 1930, pp. 133–135, 6 figs. Greater resistance has been developed by employing method of making castings under pressure and by compression; these methods impart to non-ferrous alloys properties of laminated material; first process greatly improves quality of metal giving it fine grained structure, but does not remove danger of air bubbles; second method does not have this defect but must be used only on very pure metal, otherwise malleability is reduced and cracks appear.

DIESEL-ELECTRIC POWER PLANTS

Berlin. Two 11,700-Hp. Diesel Engines Carry Peak Loads, F. J. Taylor. Power Plant Eng., vol. 34, no. 17, Sept. 1, 1930, pp. 979–981, 7 figs. Large Diesel engines installed in Berlin are characterized by compactness, simplicity of design, and effective scavenging; general plan of station showing relative location of two 11,700-hp. M.A.N. engines and auxiliary apparatus; cross sections of engine showing general conformance to standardized M.A.N. design; generators used as phase regulators; compressed-air type coupling.

DIESEL ENGINES

Compressorless. Tests on Compressorless Diesel Engines (Versuche an einer Kompressorlosen Dieselmaschine), F. Schmidt. V.D.I. Zeit. (Berlin), vol. 74, no. 33, Aug. 16, 1930, pp. 1151–1154, 6 figs. Investigation of effect of friction, cooling, and throttling on fuel consumption at different revolutions and load; determination of indicated efficiency and efficiency of ideal engine by means of exact measurement of air quantity; description of test set up and test data are given.

Fuels. New Comparative Tests of Vegetable and Mineral Oils in Diesel Engines (Nouveaux essais comparatifs des huiles végétales et minérales dans les moteurs diesel), M. Gautier. Revue des Combustilbes Liquides (Paris), vol. 8, no. 76, June-July 1930, pp. 258–263, 9 figs. Investigation of behavior of vegetable oil, such as peanut oil and palm oil in Diesel engines and their effects on engine performance and combustion character.

Scavenging. Studies of Diesel Engines—Scavenging and Charging Phenomena in Two-Cycle Engines (Untersuchungen an der Dieselmachine), K. Neumann. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens (Berlin), no. 334, 1930, pp. 1–20, 23 figs. See also V.D.I. Zeit. (Berlin), vol. 74, no. 32, Aug. 9, 1930, pp. 1109–1119, 13 figs. Experiments with Junkers opposed-piston engine equipped with special scavenging pump; test data are used as basis for mathematical investigation of scavenging phenomena; typical indicator diagrams are given.

Vibrations. Torsional Deflection in Diesel Crankshafts. Power, vol. 72, no. 7, Aug. 12, 1930, pp. 248–250, 6 figs. Outline of results of tests made recently at Oregon State College to determine difference in crankshaft distortion between load and no load.

DIPHENYL

Properties and Uses. Diphenyl May Solve Reheating Problem, G. B. Cunningham. Power, vol. 72, no. 10, Sept. 2, 1930, pp. 374–377, 1 fig. Physical and chemical properties indicate commercial success as medium for reheating steam to full initial temperature in high-pressure plants; table of physical properties of diphenyl is given; diphenyl has been used for two years in oil-refining process; welded piping is preferred; summary of diphenyl's advantages.

E

ENGINEERING LABORATORIES

Great Britain. New Engineering Laboratories at University College, Nottingham. Engineer (Lond.), vol. 150, no. 3888, July 18, 1930, p. 71, 6 figs. partly on p. 70. Account of chief points of technical interest in laboratories, and illustrating some of principal machinery for power production and distribution.

EVAPORATION

Theory. Heat Transmission, Diffusion, and Evaporation (Waermeuebergang, Diffusion, und Verdunstung), W. Nusselt. Zeit. fuer Angewandte Mathematik und Mechanik (Berlin), vol. 10, no. 2, Apr. 1930, pp. 105–121, 2 figs. Theoretical mathematical discussion with special reference to study of heat transmission by means of models; evaporation of water under various wind and temperature conditions; application of theory to design of cooling towers.

F

FANS

Testing. The Characteristics of Two-Blade Propeller Fans, H. L. Dryden and P. S. Balif. U. S. Bur. of Standards—Jl. of Research, vol. 5, no. 1, July 1930, pp. 185–211, 31 figs. Seven 2-blade propeller fans, 8 ft. in diam. and of pitch diam. ratios 0.250, 0.375, 0.500, 0.625, 0.750, 0.938, and 1.063, respectively, were tested in duct especially constructed to stimulate operating conditions encountered in cooling towers; each fan was tested for two operating conditions; with fan operating as blower, and with fan exhausting air from duct.

FLOW OF LIQUIDS

Fluidity vs. Temperature. The Fluidity of Liquids, S. E. Sheppard and R. C. Houck. Jl. of Rheology, vol. 1, no. 4, July 1930, pp. 349–371, 5 figs). Development of formula for relation

of fluidity to temperature for large number of liquids over wide range of temperature. Bibliography.

FLOW OF STEAM

Orifices. Discussion of the Flow of Steam Through Orifices and Nozzles and the Pressure Drop in Steam Pipes, G. E. Reed. Nat. District Heat. Assn.—Bul., vol. 15, no. 4, July 15, 1930, pp. 176–185, 4 figs. Paper deals principally with underlying principles of orifices and derivations leading to formula for orifice size calculation; theoretical curve of steam flow through cylindrical orifices is illustrated.

FLOW OF WATER

Curved Channels. Recent Experiment on Flow of Water in Curved Channels (Neuere Versuche Ueber den Stroemungsvorgang in Gekruemmten Kanaelen), H. Nippert. Bauingenieur (Berlin), vol. 11, no. 5, Jan. 31, 1930, pp. 76–79, 9 figs. Report on author's laboratory experiments made in Department of Hydromechanics of Danzig Institute of Technology; distribution of velocity in cross-section of curved circular pipe; eddying, distribution of velocities, and loss of head in rectangular bend and in 90-deg. curves rounded with various radii of curvatures.

FORGING

Die, Economical Methods. Work Planning and Time Estimating in Forge Shops (Arbeitsteilung und Stueckzeitvorgabe in der Schmiede), Schlingmann. Werkstattstechnik (Berlin), vol. 24, no. 15, Aug. 1, 1930, pp. 416–418, 4 figs. Discussion of economical production methods for die forging; graphic determination of lost-time factor.

FORGINGS

Nickel Alloy. Nickel Alloy Steel Forgings, C. McKnight. Am. Soc. for Steel Treating—Trans., vol. 18, no. 2, Aug. 1930, pp. 129–140 and (discussion) 140–146, 5 figs. Large forgings constitute important and constantly increasing field for alloy steel; data published by Society of Automotive Engineers on properties, analysis, and heat treatments of alloy steel are standard, but not applicable to large forgings as based on tests made on one inch bars; paper deals briefly with manufacture, uses, analysis, heat treatment, and properties of nickel alloy steel forgings larger than four inches in diameter or equivalent section.

FURNACES

Industrial, Oil-Fired. Industrial Heating With Heavy Oils (Le chauffage industriel aux huiles lourdes). Technique Moderne (Paris), vol. 22, no. 14, July 15, 1930, pp. 498–502, 5 figs. Discussion of application of heavy oils for various industrial processes; steam generation, heat-treating furnaces, blast furnaces, and ceramic furnaces; advantages, operations, and design of various types of equipment.

Melting, Pulverized-Coal-Fired. The Rotatory Furnace for Iron Founding, A. Le Thomas. Metallurgist (Supp. to Engineer, Lond.), Aug. 1930, pp. 119–120. Analysis of relative merits of new type and of cupola; account of horizontal cylindrical type of melting furnace fired with pulverized coal; flame from pulverized-fuel burner enters through aperture in one of conical ends of furnace; main advantages claimed are that iron produced is practically unaltered by melting process. Abstract translated from Revue de Métallurgie, May 1930.

G

GRINDING MACHINES

Cylinder. The New Churchill Double-Head Cylinder Grinding Machine. Brit. Machine Tool Eng. (Lond.), vol. 6, no. 64, July-Aug. 1930, pp. 105–108, 5 figs. Machine designed for simultaneous grinding of cylinder bores which are situated on same center line, but which owing to their internal construction cannot be ground straight through; hydraulic traverse provides entirely shockless reversal at highest speeds and shortest strokes; use of individual motors cuts out considerable gearing; diagram of planetary adjustments to grinding spindles.

Spindles. Designing Spindles and Mountings for Extreme Speeds, F. A. Firnhaber. Machine Design, vol. 2, no. 8, Aug. 1930, pp. 35–39, and 48, 11 figs. Discussion of important features in design of high-speed spindles, particularly for mounting of grinding wheels; notes on lubrication, protection of bearings grinding compound; sketches illustrate typical designs.

GRINDING WHEELS

Balancing. New Dynamic Balancing Machine for Grinding Wheels (Eine neue dynamische Soder-Auswuchtmaschine fuer schleifscheiben), D. Hofmann. Werkstattstechnik (Berlin), vol. 24, no. 16, Aug. 15, 1930, pp. 436–440, 17 figs. Principles and operation of machines built by Hessischen Maschinenfabrik Robert Kunze, Darmstadt; grinding wheel is clamped down on rotating disk and after balancing, center is cast before removing clamps; sketches show principal details.

H

HARDNESS TESTING

Pendulum Tests. "Pendulum" Hardness Tests of Commercially Pure Metals, D. A. N. Sandifer. Inst. of Metals—Advance Paper (Lond.), no. 529, for mtg. Sept. 9–12, 1930, 29 pp., 8 figs. Investigation limited to metallic elements; description of 24 metals tested and of hardness tester; conversion to Brinell hardness numbers; definition of time work-hardening capacity; relation between time hardnesses for different pendulum lengths; relation between scale hardness and scale work-hardening capacity; relations between time hardness, Young's modulus, and relative atomic volume; effects of rolling and of impurities.

HEAT-INSULATING MATERIALS

Flow of Heat. Transient Flow of Heat Through Insulation, A. R. Stevenson, Jr. and H. L. Bojer. Refrig. Eng., vol. 20, no. 1, July 1930, pp. 23–29, 5 figs. Theoretical mathematical analysis of heat flow with special application to variation of temperature in refrigerator; tests on transient heat flow; test with box cooled by refrigerating unit; equation for transient temperature when refrigeration is shut off.

HEAT TRANSMISSION

Convection. The Calculation of Convection Heat Transfer, M. Fishenden and O. A. Saunder. Engineering (Lond.), vol. 130, no. 3369 and 3370, Aug. 8, 1930, pp. 177–180, and Aug. 15, pp. 193–194, 7 figs. Aug. 8: Application of principle of similarity to convection; forced convection. Aug. 15: Natural convection; vertical planes; effects of shape and position on natural convection. Communication from Fuel Research Division, Dept. of Sci. and Indus. Research.

Cooling Towers. Heat Transmission, Diffusion and Evaporation (Waermeuebergang, Diffusion, und Verdunstung), W. Nusselt. Zeit. fuer Angewandte Mathematik und Mechanik (Berlin), vol. 10, no. 2, Apr. 1930, pp. 105–121, 2 figs. Theoretical mathematical discussion with special reference to study of heat transmission by means of models; evaporation of water under various wind and temperature conditions; application of theory to design of cooling towers.

HYDROELECTRIC POWER DEVELOPMENTS

California. Mokelumne—An Outstanding Hydro-Electric Project in Central California, A. H. Markwart. Elec. Light and Power, vol. 8, section 1, no. 8, Aug. 1930, pp. 28–31, 6 figs. Development of Mokelumne River is discussed; during past two years work has been progressing rapidly on six-year program for comprehensive development of stream in chain of four plants, one of which is to replace present plant; capital expenditure for hydro development, transmission and terminal substation of $39,000,000 is contemplated.

HYDROELECTRIC POWER PLANTS

Malay. The Perak River Hydro-Electric Power Scheme. Engineer (Lond.), vol. 150, no. 3893, Aug. 22, 1930, pp. 190–192, 13 figs. partly on supp. plate and p. 202. With view to supplying its numerous tin mines with power Perak River Hydro-Electric Power Co. was formed in 1926; Chenderoh power station is situated at point where river flows between two high banks; dam is hollow reinforced-concrete structure of Ambursen type; Taintor gates consist of skin plate bent to radius of 20 ft.; power house contains three vertical-shaft Francis turbines each coupled to 9000-kw. generator.

Pumped Storage. The Development of Pump-Fed Storage Power Stations in Germany. Eng. Progress (Berlin), vol. 11, no. 3, Aug. 1930, pp. 205–206, 5 figs. Installations briefly described; Escher-Wyss storage pump for power input of 27,000 hp. for Niederwartha plant; vertical shaft Escher-Wyss storage pump for power input of 8000 hp. for Leitzach plant; Voith spiral turbine of 48,000 hp. rated capacity for Herdecke plant; Voith-Sulzer pump for power input of 36,000 hp.; Voith-Foettinger hydromechanical coupling.

I

INDUSTRIAL MANAGEMENT

Cost Accounting. Automatic Registration of Work Record (Zwanglaeufige Erfassung der Arbeitsbelege), E. Volkhardt. Werkstattstechnik (Berlin), vol. 24, no. 14, July 15, 1930, pp. 386–390, 4 figs. Method for recording beginning and end of each operation; not only cost for labor but also for order are always kept up to date at little expense; blank forms illustrate record system.

Industrial Organization. Securing Simplicity in an Engineering Organization, D. E. Gray. Product Eng., vol. 1, no. 8, Aug. 1930, pp. 364–366, 3 figs. Organization of mechanical development department of Corning Glass Works which is engaged in development of new methods and in design and development of special equipment and machinery for economic production of products made of glass.

Inventory Control. The Case of Management vs. Excessive Inventories, H. Soper. Factory and Indus. Mgmt., vol. 80, no. 3, Sept. 1930, pp. 501–503 and 524, 4 figs. Application of methods used in manufacture of toilet articles by which Greenfield Tap and Die Corp., Greenfield, Mass., is able to make 100 per cent deliveries from 20,000-item line.

Time Study. Efficiency Limits for Speed of Operation (Wirtschaftliche Begrenzung der Arbeitsgeschwindigkeit), O. Steinitz. Maschinenbau (Berlin), vol. 9, no. 16, Aug. 21, 1930, pp. 546–548, 1 fig. Determination of economical speed for operations in which expenses grow faster than working speed; general formulas are developed and practical examples are followed through.

Tables and Alignment Charts (Zahlentafeln und Nomogramme), E. Lehmig. Maschinenbau (Berlin), vol. 9, no. 14, July 17, 1930, pp. 480–483, 6 figs. Application of numerical charts and nomograms for determination of working time is discussed; nomograms for determining machining time for machines with rotating and reciprocating motion are given; notes on making and use of special slide rule.

Training Time-Study Men With Motion Picture Camera, A. H. Morgensen. Factory and Indus. Mgmt., vol. 80, no. 3, Sept. 1930, pp. 511–512, 3 figs. Use of motion pictures in training new time-study men and in maintaining consistency among older men.

INDUSTRIAL PLANTS

Electric Power for. Power Plants for Modern Factories (Une Centrale d'Usine Moderne), P. Mensier. Société des Ingénieurs Civils de France—Mémoires et Compte Rendu des Travaux (Paris), vol. 83, no. 3–4, 1930, pp. 280–324, 18 figs. Notes on economic production of power in factory which consumes large quantities of steam in production process; steam distribution at various pressures; bleeding turbines and boiler feedwater; detailed study of clothing and dyeing plant in Tourcoing in need of 2000 kw. and steam for heating at 6 and 3 kg. pressure; equipment installed for driving of 1800-kw. turbo-generator of 30-kg. pressure.

INDUSTRIAL TRUCKS

Gasoline. A New Form of Factory Truck. Engineer (Lond.), vol. 150, no. 3892, Aug. 15, 1930, p. 182, 4 figs. Particulars of run-about truck for factory transport, and such-like services produced by Brett's Patent Lifter Co.; driven by gasoline engine, it is of three-welded type in which steering and driving wheel and motor are built up into one unit.

INTERNAL-COMBUSTION ENGINES

Air Filters. The Efficiency of Air Filters for Internal-Combustion Engines, W. E. Gibbs, A. Brandt and M. L. Nathan. Engineering (Lond.), vol. 130, no. 3371, Aug. 22, 1930, pp. 221–223, 7 figs. Principles governing action of airfilters; principle of centrifugal separation is employed in two types, cyclone and perforated-baffle type; filters chosen to represent these are representative cyclone model and Visco RM filter; their efficiencies have been determined; superior efficiency of Visco filter is due to much smaller radius of curvature imparted to air stream, combined with greater proximity of depositing surface, which results from closeness of perforated plates to one another.

Efficiency. Investigation on Volumetric Efficiency of Two-Cylinder Two-Cycle Engine With Crankcase Compression (Untersuchung ueber den volumetrischen wirkungsgrad an einem Zweizylinder-Zweitaktmotor mit Kurbelkammergemischpumpe), F. Buchholz, L. Hoffmann, and K. Joachimssohn. Automobiltechnische Zeit. (Berlin), vol. 33, no. 21, July 31, 1930, pp. 505–510, 8 figs. Determination of volumetric efficiency at vacuum of from 0 to 1200 mm. water

between 800 and 2000 r.p.m. by direct measurement of air quantity and by calculating air quantity from fuel consumption and exhaust-gas analysis.

High-Speed. Requirements and Problems of High Speed in Piston Engines (Anforderungen und Problems des Schnellaufs bei Kolbenmaschinen), F. Modersohn. Maschinenbau (Berlin), vol. 9, no. 14, July 17, 1930, pp. 465–470, 18 figs. Discussion of factors determining life of vital parts of high-speed engine; materials, accuracy, surface property, and lubrication; typical cases of wear are illustrated by micro-photographs.

Oil Purifiers. Continuous Purification of Lubricating Oils for Internal Combustion Engine During Period of Running in on Road and Testing (Epuration continue des huiles de graissage des moteurs à explosion en cours de rodage et d'essais), A. Petit. Technique Automobile et Aérienne (Paris), vol. 21, no. 148, 1930, pp. 10–15, 12 figs. Discussion of advantages of various systems; sketches show details on design and set-up of Perrier centrifuges.

Two-Cycle. Working Process of High-Speed Two-Cycle Carburetor Engines (Das Arbeitsverfahren raschlaufender Zweitaktvergaser-Maschinen), O. Kluesener. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens (Berlin), no. 334, 1930, pp. 21–46, 47 figs.; see also V.D.I. Zeit. (Berlin), vol. 74, no. 33, Aug. 16, 1930, pp. 1154–1156, 13 figs. Investigation of process in two-cycle engines with crankcase compression; report on scavenging tests and combustion velocity at speeds up to 3500 r.p.m.; complete thermal budget is given.

Welding. Welding Practice on Heavy Engines, O. Adams. Welding, vol. 1, no. 10, Aug. 1930, pp. 674–677, 7 figs. Description of repairs to pistons, cylinder heads, and cylinders of gas and Diesel engines; costs of welding, method of preheating, electric arc welding, and bronze welding.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; OIL ENGINES.]

IRON FOUNDRIES

Large Castings. The Production of Large and Medium-Sized High-Class Iron Castings, W. Scott. Foundry Trade Jl. (Lond.), vol. 43, no. 729, Aug. 7, 1930, pp. 91–96 and 98, 29 figs. Methods used by Close Foundry of Armstrong, Whitworth and Co. for manufacturing marine, Diesel, and steam-turbine castings. Paper read before Inst. of Brit. Foundrymen.

L

LOCOMOTIVES

Boosters. Some Notes on the Locomotive Booster, T. G. Atkinson. Locomotive (Lond.), vol. 36, nos. 453, 454, and 455, May 15, 1930, pp. 161–165, June 14, pp. 204–208 and July 15, pp. 230–232, 12 figs. May 15: Development of booster in Great Britain; mathematical analysis and curves illustrating effect of booster operation. June 14: Discussion of booster draw-bar pull at various speeds as illustrated by curves; chart for determining steam consumption of booster. July 15; Details of clutch cylinder are described and illustrated; interlocking arrangements of booster.

Design. Steam Locomotive Design: Data and Formulae, E. A. Phillipson. Locomotive (Lond.), vol. 36, nos. 449, 450, 451, 452, 453, 454, 455, and 456, Jan. 15, 1930, pp. 15–17; Feb. 15, pp. 61–63; Mar. 15, pp. 86–90; Apr. 15, pp. 120–123; May 15, pp. 151–152, June 15, pp. 210–211;. July 15, pp. 241–244; Aug. 15, pp. 263–265; 5 figs. Jan.: Mathematical calculation of design features dealing with train resistance, resistance due to acceleration, gradient resistance, curve resistance, and natural wind resistance. Feb.: General remarks, definitions, and data; determination of such factors as evaporative heating surface required per i.hp. developed, boiler demand factor, and engine performance data. Mar.: Estimating steam consumption; calorific value and combustion of fuel; grate area. Apr.: Determination of firebox and tube heating surface; superheater surface; table of leading dimensions and design ratios of tank, freight, mixed traffic, and passenger express locomotives. May: Discussion of cardinal points of design. June: Consideration of boiler together with mathematical determination of barrel-plate thickness. July: Consideration of boiler riveted joints and firebox plates; relative merits of steel and copper for inner fireboxes; wide versus narrow fireboxes; relative merits of Belpaire and round topped fireboxes. Aug. Design features of combustion chambers, foundation ring, fusible plug, brick arch, deflector plates, and firebars.

Draft. Improving Draft Efficiency, G. W. Armstrong. Ry. Mech. Engr., vol. 104, no. 9, Sept. 1930, pp. 499–502 and 507, 8 figs. Annular-ported exhaust nozzle with suitably proportioned stack reduces back pressure; indicator cards comparing 4½-in. and 5-in. circular exhaust tips; University of Illinois tests; summary of standing tests of U.S.R.A. 2-8-2B type locomotive; draft diagrams of various locomotives are illustrated.

Electric. Double-Voltage Operation Features Midland Utilities Locomotive. T. F Perkinson. Elec. Ry. Jl., vol. 74, no. 9, Aug. 1930, pp. 524–525, 2 figs. Service can be given on 1500 or 600-volt lines on its several subsidiary railways by changes of circuits and minor adjustments principal data of double-voltage locomotives is listed.

Electric Locomotives With Welded Frame and Trucks (Elektrische Lokomotive mit geschweissten Rahmen und Drehgestellen), W. Reichel. V.D.I. Zeit. (Berlin), vol. 74, no. 23, June 7, 1930, pp. 767–768, 5 figs. Brief description of welded frame construction used for electric locomotives with individual axle drive; outline of principal types of locomotives built by Siemen Schuckert.

Vertical Motors Feature Austrian Locomotives. Elec. Ry. Jl., vol. 74, no. 9, Aug. 1930, pp. 511–512, 5 figs. Locomotive drive of type differing radically from that in use in America has been found successful on lines of Austrian Federal Railways; principal feature is use of vertical motors connected to driving axles through bevel gears; drive is somewhat similar to that brought out short time previously by Midi Railway of France; specifications of high-speed locomotives are listed.

Feedwater Heaters. Utilization of Exhaust Steam for Preheating of Feedwater for Locomotive Boilers (Traction à vapeur—L'utilisation des vapeurs d'échappenment et le réchauffage de l'eau d'alimentation des chaudières de locomotives), G. Vié. Science et Industrie (Paris), vol. 14, no. 199, Aug. 1930, pp. 598–605, 4 figs. Description of preheating systems by Caille-Potonie, Worthington, and Acri.

High-Pressure. Experimental Multiple Pressure and New Freight Locomotives. Canadian Pacific Ry. Locomotive (Lond.), vol. 35, no. 456, Aug. 15, 1930, pp. 260–261, 1 fig. At Angus Shops of C. P. Ry. in Montreal, three-cylinder locomotive is being constructed which generates high-pressure steam on Schmidt system; 2-10-4 type with high-pressure cylinder 15½ in., by 28 in., and two low-pressure cylinders 24 in. by 30 in.; driving wheels 5 ft. 3 in.; working pressure 275 lb. per sq. in.; nominal tractive force at 85 per cent boiler pressure, 83,000 lb.; total weight of engine 466,000 lb.; engine wheelbase 46 ft. ½ in.

High-Pressure Locomotive Being Tested in Germany. Ry. Mech. Engr., vol. 104, no. 9, Sept. 1930, pp. 491–496, 10 figs. Loeffler principle of steam generation; design and operation of boiler; features of closed-circuit construction; design and general arrangement; expected economies; plan and elevation views together with principal dimensions and weights have been previously indexed from various sources.

Locomotive No. 10,000. Engineer (Lond.), vol. 150, no. 3891, Aug. 8, 1930, p. 149. Editorial comment on performance of H. N. Gresley's high-pressure locomotive on London and Edinburgh service; prophets who had had experience with water tubes in locomotive practice were confident that in short time tubes would fur up; that has not happened; arrangement adopted for causing deposition of scale-making material in forward part of steam drum has proved effective and scaling of tubes is negligible; confidence is expressed that in this all-British design one of most practical solutions of high-pressure locomotive problem yet advanced has been found.

The Schwartzkopff-Loeffler Ultra-High-Pressure Locomotive, Malec. Eng. Progress (Berlin), vol. 11, no. 8, Aug. 1930, pp. 207–211, 7 figs. Locomotive described has working pressure of 1420 lb. per sq. in. and is 3-cylinder compound unit with two external high-pressure cylinders; theoretical saving of coal is 47 per cent as compared with modern superheated-steam locomotives.

Third High-Pressure Locomotive on the D.&H. Ry. Age, vol. 89, no. 4, July 26, 1930, pp. 143–147, 8 figs. Locomotive operates at boiler pressure of 500 lb.; water-tube firebox and boiler similar in design to those of "Horatio-Allen" and "John B. Jervis;" cylinders hp. 20½ in. by 32 in., I.P. 35½ in. by 32 in.; driving wheels 63 in.; steam pressure 500 lb. per sq. in.; tractive force, simple, 84,300 lb.; total engine wheel base 29 ft.; total engine weight in working order, 356,000 lb.

2C 1 High-Pressure Locomotive of German State Railroad (Die 2C 1-Hochdruck (120 at)-Lokomotive der Deutschen Reichsbahn), Witte and R. P. Wagner. V.D.I. Zeit. (Berlin), vol. 74, no. 31 and 32, Aug. 2, 1930, pp. 1073–1078 and Aug. 16, pp. 1141–1143, 36 figs. Aug 2: Methods for overcoming difficulties in applying Loeffler principle to locomotives; design of locomotive and details on high-pressure system; economizers and superheaters; centrifugal pump for Loeffler boiler and high-pressure valve for locomotive cylinder; sketches show principal details.

Oil-Electric. Economics of the Oil-Engine Locomotive, A. I. Lipetz. Ry. Age, vol. 89, no. 9, Aug. 30, 1930, pp 451–455, 2 figs. Comparative data from seven railroads for oil-electric and steam locomotives analyzed; road operating costs; effect of high availability; established trends in America. Portion of report on Question V—Locomotives of New Types, presented before Int. Ry. Congress Assn., Madrid, Spain.

Plants, Switzerland. The Oerlikon Works Locomotive (London), vol. 36, no. 454, June 14, 1930, pp. 190–194, 8 figs. Brief historical review of operations; recent additions have increased area to 120,000 sq. m., of which 65,000 sq. m. are covered by buildings; average of 3000 workmen and staff employed; illustrated description of buildings, equipment, and plant operation.

Valve Gears. A New Locomotive Poppet Valve Gear. Ry. Engr. (Lond.), vol. 51, no. 608, Sept. 1930, pp. 355–357, 2 figs. Perfect timing for all valve events up to 84 per cent cut-off, simple control, and low first cost are among advantages claimed for Holmes Gear, which is illustrated and described.

LUBRICATION

Theories. Coefficient of Fluid Friction (Au sujet du coefficient du frottement fluide), Hanocq. Revue Universelle des Mines (Liege), vol. 4, no. 2, July 15, 1930, pp. 33–38, 6 figs. Elementary theory of film lubrication; experimental verification of theory; study of semi-fluid friction; conclusions regarding coefficient of friction. See reference to author's earlier work indexed in Engineering Index, 1929, p. 1107.

M

MACHINE-SHOP PRACTICE

Planing vs. Milling. Planning or Milling (Hobeln oder Fraesen?), O. Rieckhoff. Maschinenbau (Berlin), vol. 9, no. 15, Aug. 7, 1930; pp. 501–505, 17 figs. Critical discussion of efficiency of both milling and planing operation, examples show that work mostly done on planer can be machined more advantageously by milling; specific data on cost of various operations are given.

MACHINE TOOLS

Design. Trend of Development of Metals Cutting Machine Tools (Die Richtlinien fuer die Entwicklung spangebender Werkzeugmaschinen). E. Preger and H Haeneke. Maschinenbau (Berlin), vol. 9, no. 10, May 15, 1930, pp. 325–340, 49 figs. Developments in design of principal types of machine tools with regard to drives, gears, output, accuracy, economy of operation, standardization, and possibilities of future development; specific data on German makes.

Hydraulic Drive. Machine Tools for Metals Cutting With Hydraulic Drive and Their Calculations (Spanabhebende Werkzeugmaschinen mit Fluessigkeitsgetrieben und deren Berechnung). F. H. Huth. Maschinen-Konstrukteur (Berlin), vol. 63, no. 13, July 10, 1930, pp 266–269, 8 figs. Description of Blell-Hydro planer and its hydraulic drive; examples for computing dimensions and performance of pump and motor of hydraulic drive.

MATERIALS HANDLING

Forge Shops. Study of Handling Losses in a Forge Shop (Untersuchungen ueber Foerderverluste in einer Gesenkschmiede), W. Schoening. Archiv fuer das Eisenhuettenwesen (Duesseldorf), vol. 4, no. 1, July 1930, pp 45–54, 17 figs. Handling methods in storage yard and in shop; description of improvements and successful results obtained therewith; study of power and time losses in crane operation; storage losses.

Foundries. Materials-Handling Costs in Jobbing Foundries, F. D. Campbell. Foundry Trade Jl. (Lond.), vol. 43, no. 730, Aug. 14, 1930, pp. 105–107. Necessity for proper foundry layout; arrangement and type of equipment labor costs; handling methods.

Sheet-Metal Working. Materials Handling in Large Stamping Plant, A. K. Burditt and W. F. Schaphorst. Metal Stampings, vol. 3, no. 8, Aug. 1930, pp. 705–708, 6 figs. Description of

sequence of operations and materials-handling equipment employed to facilitate production and assembly of oil filters for automobiles; applications of conveyors, tote boxes, and special trucks.

MATHEMATICS

Fairing Empirical Series. Smoothing of Empirical Series (Das Glaetten empirisch gefundener Zahlenreihen), A. Willers. Zeit. fuer angewandte Mathematik und Mechanik (Berlin), vol. 10, no. 2, Apr. 1930, pp. 166–181. Theoretical mathematical discussion on reduction of experimental data.

METALS

Deformation. Some Applications of the Theory of Plastic Deformations of Ductile Metals, A. Nadai. Phys. Rev., vol. 36, no. 4, Aug. 15, 1930, pp. 762–772, 4 figs. Account of principal conditions which are available to express equilibrium of stress in plastic of ductile metals; ease of rotationary symmetry in plastic body; plastic flow in thick-walled cylinder subjected to high internal pressure with and without longitudinal expansion; distribution of stress during yielding for long cylinder and for flat ring, both subjected to radial pressure; spread of yielding and plastic deformation through walls of cylinder.

Hard-Facing. The Metallurgy of Welded-On Overlays, M. C. Smith. Welding, vol. 1, no. 10, Aug. 1930, pp. 681–683 and 688, 5 figs. Discussion of structural changes and formation of alloys which take place in hard facing; technique of applying overlay.

X-Ray Analysis. A Study of Crystal Structure and Its Applications, T. A. Wilson. Gen. Elec. Rev., vol. 33, no. 9, Sept. 1930, pp. 528–534, 8 figs. Calculation of crystal orientation from unsymmetrical Laue photographs; table of interperpendicular angles of body-centered cubic lattice in order of increasing angle; table of interperpendicular angles involving cube face, body-centered cubic system; application to actual determination of orientation of crystal.

N

NON-FERROUS METALS

Cold Rolling. Modern Practice in the Cold Rolling of Non-Ferrous Metals, C. E. Davies. Metallurgia (Manchester), vol. 2, no. 10, Aug. 1930, pp. 145–146. Copper, brass, nickel, aluminum, and zinc group, precious-metals group, and soft-metals group are handled by machinery and methods that are alike in principle; modifications in detail are governed by different physical properties of individual metals and alloys; outline of brass strip practice.

O

OIL ENGINES

Automotive, Hesselman's. Hesselman's Low-Pressure Crude-Oil Engine (Hesselman's Lagtrycks-Raoljemotor), E. Hubendick. Teknisk Tidskrift (Stockholm), vol. 60, no. 28, July 12, 1930, pp. 417–427, 31 figs. First authentic and complete account of low-pressure petroleum engine to be used in automobiles, small boats, and locomotives; test show saving over gasoline consumption of 30 per cent and in fuel cost of 68 per cent; same capacity fuel tank will carry car 43 per cent farther than gasoline.

New Oil Engine for Motor Vehicles (Neuer Oelmotor fuer Kraftfahrzeuge), A. Heller. V.D.I. Zeit. (Berlin), vol. 74, no. 28, July 12, 1930, pp. 970–972, 9 figs. Description of Hesselman high-speed spark-ignition engines; performance curves are given.

Hesselman New Low-Pressure Oil Engine (Hesselmans neuer Niederdruck-Oelmotor), C. A. Fieber. Sparwirtschaft (Vienna), vol. 8, no. 7, July 1930, pp. 327–331, 10 figs. Outline of advantages of Hesselman engine and report on result obtained with four-cylinder engine built by Grazer Waggon und Maschinen-Fabriks-Actien-gesellschaft.

Ruston and Hornsby. The Ruston High-Speed Airless-Injection Oil Engine. Engineering (Lond.), vol. 130, no. 3371, Aug. 22, 1930, p. 247, 6 figs. partly on p. 246. Engine runs at 900 r.p.m. and can be supplied either as stationary model for belt or direct drives, or arrange for fitting in commercial vehicles, tractors, and so on; cylinder heads are separate castings, held down by studs; inlet and exhaust valves are interchangeable, and both are operated from single camshaft located in crankcase.

P

PIPE, CAST IRON

Centrifugal Casting. Casts Pipe in Eighteen Foot Lengths, P. Dwyer. Foundry, vol. 58, no. 15, Aug. 1, 1930, pp. 104–109, 10 figs. Description of manufacturing process and equipment at plant of National Cast Iron Pipe Co., Birmingham, Ala.; notes on synchronization of operation, tests, and inspection of pipes.

PLANERS

Metal-Working—Manufacture. Grinding or Scraping? (Schleifen oder Schaben?), W. Iwascheff. Werkstattstecknik (Berlin), vol. 24, no. 15, Aug. 1, 1930, pp. 405–410, 10 figs. Superiority of grinding as compared to scraping is outlined; characteristics of scraped and ground surfaces are discussed with regard to structure and suitability for lubrication; detailed description of planing and grinding operation on cheeks of planer bed; data on tolerances.

POWER CONFERENCES

Berlin. The Second World Power Conference, Berlin, 1930 (Von der II. Weltkraftkonferenz, Berlin, 1930), C. Matschoss. V.D.I. Zeit. (Berlin), vol. 74, no. 29, July 19, 1930, pp. 993–1040. Abstract of papers and discussions of general sessions, including addresses by Einstein, Eddington, and others; also report on proceedings of following special sections; Fuels, Steam Power, Internal Combustion Motors, Water Power Power Storage, Electricity, Use of Various forms of Power, Standardization and Statistical Methods, etc.

The World Power Conference, Berlin. Engineering (Lond.), vol. 130, nos. 3366 and 3367, July 18, 1930, pp. 91–92, and July 25, pp. 125–126. July 18: Abstracts of selected papers relating, respectively, to liquid and solid fuels and power economics. July 25: Research work; research divided into two definite parts dealing, respectively, with hydrodynamics and kindred matters, and thermodynamics; costs and comparative efficiency of different types of energy.

POWER PLANTS

Load Despatching. Some Notes on the Centralised Control System of the Victoria Falls and Transvaal Power Company, Limited, J. Falcke. S. African Inst. of Elec. Engrs.—Trans. (Lond.), vol. 21, part 5, May 1930, pp. 105–115, 7 figs. General idea of control diagram and principles upon which system is operated; evolution of centralized control system; office; indicating and recording instruments; summating wattmeters; communication system; compressed air diagram; load graph; duties of control engineer; operating requirements; continuity of supply and protection; reliability of service; transmission system; power factor and interconnection.

PRESSURE INDICATORS

Precision. Precision Measurement of Liquid Pressure. Engineer (Lond.), vol. 150, no. 3890, Aug. 1, 1930, pp. 116–117, 11 figs. That it is possible to construct highly efficient mercury column for high pressures has been proved by Budenburg Gauge Co. who has fitted up standard mercury column at its works for pressures up to 300 lb. per sq. in.; in precision dead weight testers pressure of liquid, usually oil or glycerine, is balanced by weight of loaded piston floating in cylinder.

R

RAIL MOTOR CARS

Gasoline. Petrol Engine Cars for the Brazilian Central Railways, O. Schamberger. AEG Progress (Berlin), vol. 6, no. 8, Aug. 1930, pp. 259–264, 10 figs. Four-axle cars with double-engine equipment of four cylinders with 150 mm. bore and 180 mm. stroke which develop 100 b.hp. at 1000 r.p.m.; four-speed friction clutches; electro-pneumatic train control.

Storage-Battery. Accumulator Driven Rail Vehicles in Europe, P. L. Balbo. Tramway and Ry. World (Lond.), vol. 68, no. 8, Aug. 14, 1930, pp. 75–76. Discussion of problems associated with storage-battery drive as applied to electric-railroad cars and buses; historical review of this type of drive; results of experiments carried out in various cities of Europe. Abstract of paper presented at Congress of Int. Tramways Union at Warsaw.

REFRIGERATING COMPRESSORS

Design. The Design of Compressors, B. C. Oldham. Refrig. Eng., vol. 20, no. 2, Aug. 1920, pp. 83–93, 9 figs. Following design features of compressor cylinder are discussed; valves, piston, speeds, types, frames; special problems of refrigeration cycle; comparison curves of pressure ratios of refrigerants; capacity as related to compressor design; motive power of refrigerants.

REFRIGERATING MACHINERY

Quick-Freezing. Direct Expansion Quick-Freezing Machine, H. G. Miller. Ice and Refrig., vol. 79, no. 2, Aug. 1930, pp. 128–129, 1 fig. Device which inventors claim possesses qualities entirely foreign to any other quick-freezing system; initial cost is low; minimum floor space required; temperature can be raised or lowered in very short time; minimum labor expense; ease of operation.

REFRIGERATION

Frozen-Brine. Frozen-Brine Refrigeration, D. K. Warner. Ice and Refrig., vol. 79, no. 2, Aug. 1930, pp. 126–127, 2 figs. Application of frozen-brine principle to household refrigeration in place of water ice and its advantages as refrigerant; cost of producing frozen-brine; process is comparable to old ice-cream freezer; will hold refrigerator colder with more constant temperature and humidity.

New Refrigerating and Ice-Making System, D. K. Warner. Ice and Refrig., vol. 79, no. 2, Aug. 1930, pp. 79–82, 6 figs. Principles of new experiments; requirements of ammonia floats; constant humidity refrigerator operated with frozen-brine; improvement on barometric con denser; mechanical refrigerator with varying temperatures. Address delivered before Am. Soc. Refrig. Engrs.

ROLLING MILLS

Aluminum. Rolling Mills, Alloying, and Presswork of Aluminium Industrie A.-G., Neuhausen (Die neuen Legierungs-Walz- und Presswerke der Aluminium-Industrie A.-G. Neuhausen), Zeerleder. Schweizerische Bauzeitung (Zurich), vol. 96, no. 2, July 12, 1930, pp. 15–22, 30 figs. Description of layout, operating methods, and equipment of new Swiss aluminum rolling mills; data on capacity of machinery and power requirements are given.

Electric Drive. How Special Motors and Control Solved Continuous Hot-Rolling Problems, R. H. Rogers. Elec. World, vol. 96, no. 8, Aug. 23, 1930, pp. 352–357, 8 figs. Methods used to obtain compact but accessible motor room; purposes served by four-element motor-generators; avoid starting compensators; use of two-in-one roughing-mill motor; motors and control for successive finishing rolls at proper relative speeds, starting roughing-mill speed of finishing-mill motors; regulating relative speeds of six motors within 0.1 per cent; centralized motor control and load and speed indication.

Flow in Rolling. Influence of Lateral Pressure on Deformation in Rolling and on Quality of Material (Der Einfluss des Seitendruckes auf die Formaenderung beim Walzen und die Guete des Werkstoffes), H. Hilterhaus. Stahl und Eisen (Duesseldorf), vol. 50, nos. 34 and 35, Aug. 21, 1930, pp. 1185–1194 and Aug. 28, pp. 1221–1229, 31 figs. Review of different theories on flow of material with rolling; results of author's own tests on three-high mill; evaluation of tests.

Research. Studies of Efficiency and Power Consumption for Different Roll Sections (Untersuchungen zur Feststellung der Leistungsfaehigkeit und des Kraftverbrauches fuer verschiedene Walzprofile), G. Bulle, C. N. Elsen, and A. Knickenberg. Stahl und Eisen (Duesseldorf), vol. 50, no. 32, Aug. 7, 1930, pp. 1121–1126, 12 figs. Time and energy-consumption measurements were carried out on five rolling mills showing that graphic record of structural units of mill could be easily obtained; investigation of energy consumption for determination of starting energy, no-load output, and productive rolling work, by which is understood work that roll motor has to perform in excess of work at no load.

S

SAND BLAST

Nozzles. Capacity and Efficiency of Sand-Blast Nozzles (Leistung und Wirkungsgrad von Sandstrahlduesen) Nettmann and Faber. V.D.I. Zeit. (Berlin), vol. 74, no. 35, Aug. 30, 1930, p. 1200, 2 figs. Abstract of V.D.I. Bulletin on

tests of wooden nozzles operated with sand grains of steel shot; erosive effect of blasted materials upon shape of nozzle channel.

SCREW THREADS

Dardelet. Tests on Dardelet Bolts and Nuts. Machy. (Lond.), vol. 36, no. 930, Aug. 7, 1930, pp. 588–590, 4 figs. Results of tests made by National Physical Laboratory comparing strength of bolts threaded with Dardelet thread with those with B.S.W. and B.S.F. threads.

SHAFTS AND SHAFTING

Stresses in. Shaft Stresses Due to Torsional Impact, W. A. Tuplin. Engineer (London), vol. 150, no. 3890, Aug. 1, 1930, pp. 112–115, 5 figs. Loss of kinetic energy when two masses rotating at different speeds are suddenly connected is determined by considerations of angular momentum; calculations assume that whole of lost kinetic energy is transformed into torsional strain energy of shafts; in practice there will be other strains; however methods outlined give stresses which are higher than true values and therefore err on safe side.

SHAPERS

Machining Time for. Simple Chart for Calculating Machining Time on Horizontal Shapers (Einfache Gebrauchstafel zur Vorkalkulation von Waage rechstossarbeiten), E. Preger. Maschinenbau (Berlin), vol. 9, no. 15, Aug. 7, 1930, pp. 509–512, 6 figs. Methods for drawing charts to be used in calculating rectangular surfaces machined on horizontal shaper driven by rack or by crank; charts are suitable for individual and for small production.

SOLAR ENERGY

Utilization of. Generation of Power by Direct Transformation of Solar Heat (Production de force motrice par transformation directe de la chaleur solaire), H. Delecourt. Revue Universelle des Mines (Liége), vol. 4, no. 4, Aug. 15, 1930, pp. 97–106; Sept. 1, pp. 137–147, 14 figs. Aug.: Historical review importance of available energy; work of Claude and Boucherot; production of power by utilization of intermediate cycle; utilization of ethyl-chloride vapor cycle; choice of auxiliary fluid; experimental plant of Brabant at Oisquercq; theoretical study of cold vapor cycle. Sept.: Application of recuperation to steam turbine; comparison between exhaust-steam turbine and ethyl-chloride turbine; results of tests at Brabant central station at Olisquercq; details of solar engine; net cost of solar kilowatt-hour; utilization of energy produced and future possibilities.

SOUND

Measurement of. Full Automatic Reverberation Measuring Equipment (Ueber eine vollautomatische Nachhallmessvorrichtung), M. J. O. Strutt. Elektrische Nachrichten-Technik (Berlin), vol. 7, no. 7, June 1930, pp. 280–282, 2 figs. Improved equipment consisting of microphone and vacuum-tube amplifier containing Philips B 405 tube and by which reverberation time can be measured within 0.01 of second exact.

Investigation of Sound Damping Materials (Ueber die Untersuchung von schalldaempfenden Koerpern), H. Tischner. Elektrische Nachrichten-Technik (Berlin), vol. 7, no. 6, June 1930, pp. 236–247, 10 figs. In previous article in May 1930, issue of same journal propagation of sound in tubes was studied by means of compensating equipment and measuring telephone; with same equipment influence of various damping materials on sound propagation in tubes is investigated.

New Automatic Method for Measuring of Reverberation (Ein neues automatisches Verfahren der Nachhallmessung), E. Meyer. Zeit. fuer Technische Physik (Leipzig), vol. 11, no. 7, 1930, pp. 253–259, 9 figs. Graphical construction of reverberation process; control of stop watch; glow lamps, and tube relays; measuring method; examples showing exactitude; influence of air humidity of sound absorption decrement of tuning forks.

SPEED RECORDERS

New Types. New Instruments, D. C. Gall. Jl. of Sci. Instruments (Lond.), vol. 7, no. 7, July 1930, pp. 230–231, 2 figs. Variable but constant-speed recording drum, 12 in. diam. by 12 in. long, arranged to be driven at any constant speed between 9 and 12 r.p.m.; high degree of constant speed obtained by phonic motor and electrically maintained tuning-fork.

SPRINGS

Stresses in. Stress Strain Relationships in Spring Steels, G. A. Hankins. Engineer (Lond.), vol. 150, no. 3892, Aug. 15, 1930, pp. 178–179, 1 fig. Discussion of stress strain under conditions which are often assumed to be elastic; experimental results on changes in elastic moduli after excessive overstraining of material. Communication from Springs Committee of Department of Sci. and Indus. Research Bibliography.

STANDARDIZATION

Paris Conference. The Paris Conference of the International Standards Association, J. Gaillard. Am. Standards Assn. (A.S.A.)—Bul., no. 53, Sept. 1930, pp. 3–13. Report covers purpose of International Standards Assn., and results of technical conferences on paper sizes, technical drawings, twist drills and other small tools, test pressures for acceptance of new stationary steam boilers, wrench openings (widths across flats of bolt heads and nuts), rivets, coal, petroleum products, traffic signals, fluid meters.

STEAM ACCUMULATORS

Ruths. Economy of Ruths Accumulator (Wirtschaftlichkeit der Ruthsspeicher), C. Nunn. Maschinen-Konstrukteur (Berlin), vol. 63, no. 13, July 10, 1930, pp. 270–273, 5 figs. Discussion of effect of accumulator on production cost; practical examples from sugar-beet industry are followed through; data on amortization.

Investigation of 50,000-Kw. Ruths Accumulator (Untersuchungen an einer 50,000 Kw-Ruthsspeicheranlage), W. E. Wellmann. V.D.I. Zeit. (Berlin), vol. 74, no. 23, June 7, 1930, pp. 743–753, 18 figs. Description of boiler, turbine, and steam accumulator plant of Charlottenburg Power Plant of BEWAG; detailed discussion of test data and performance of accumulator in meeting peak load; full data on cost of construction and efficiency of plant are given.

Peak-Load Compensation by Means of Ruths Steam Accumulator (Spitzendeckung in Elektrizitaetswerken durch Dampfspeicher, insbesondere Ruthsspeicher), E. Praetorius. Brennstoff und Waermewirtschaft (Halle), vol. 12, nos. 13/14 and 15/16, July 1930, pp. 174–179, and Aug., pp. 194–197, 10 figs. Requirements of peak-load power plants and use of Ruths accumulators for peak-load equalization; examples of Ruths accumulator installations and operating experiences.

Significance of Ruths Accumulators in Electric Power Practice (Die Bedeutung des Ruthsspeichers fuer die Elektrizitaetswirtschaft), T. Stein. V.D.I. Zeit. (Berlin), vol. 74, no. 23, June 7, 1930, pp. 754–760, 38 figs. Discussion of special features of Ruths plant at Charlottenburg and comparison with similar plants in other countries; possibilities of Ruths accumulators in making electricity supply more economical and preventing interruption are outlined; diagram illustrates efficiency of Ruths accumulators and turbines with regard to peak loads.

STEAM CONDENSERS

Latest Installations. Condensing Equipment. Nat. Elec. Light Assn.—Report, no. 069, July 1930, 37 pp., 46 figs. Tables showing characteristics of latest condenser installations indicate increased use of single-pass condensers for large capacity; condensers with tubes rolled at both ends are in satisfactory operation; satisfactory results for use of chlorine in circulating water; $^{7}/_{8}$-in. tubes are being used more frequently.

Maintenance and Repair. Condenser Maintenance: Its Influence on Turbine Performance. Power, vol. 72, no. 9, Aug. 26, 1930, pp. 349–351, 5 figs. Aside from occasional tube renewals, cleaning, and stopping leakage of circulating water and air into steam space sums up maintenance work that generally has to be done on condensers; careful attention of engineer is demanded and neglect may result in loss of turbine economy and feedwater troubles; condenser operating data plotted to show effect of tube fouling and cleaning.

Surface. Dimensioning of Surface Condensers (Die Bemessung von Oberflaechenkondensatoren), P. Danninger. Ardhiv. fuer Waermewirtschaft (Berlin), vol. 11, no. 9, Sept. 1930, pp. 305–307, 2 figs. Values governing dimensioning of condensers are established, formulas are covered from them, and diagram is developed.

STEAM-ELECTRIC POWER PLANTS

California. Steam Power Development of the Pacific Gas & Electric Company, R. C. Powell. Am. Inst. Elec. Engrs.—Advance Paper, for mtg. no. 30–147, Sept. 2–5, 1930, 6 pp., 2 figs. After brief history of development of steam power on system of Pacific Gas & Electric Co., fundamental factors entering into problem of providing additional steam plant capacity for this company in accord with changed economic conditions are described; recent work completed and under construction are described some of economic results obtained and expected are given.

Canada. Saskatoon's New 10,000 Kw. Steam Unit. Elec. News (Toronto), vol. 39, no. 14, July 15, 1930, pp. 45–47 and 61, 4 figs. Province of Saskatchewan installs high-pressure steam-electric plant as part of big program; initial installation of main generating equipment in this new plant consists of one 10,000 kw. turbine-driven generator with 60 kw., 250 volt direct-connected exciter; current is generated at 13,200 volts, three-phase, 60 cycle, and distributed through underground circuits from new station at generator voltage or to old station through two banks of transformers; notes on design features and station auxiliaries.

Oklahoma. Burning Pulverized Petroleum Coke With Success, G. D. Conley. South. Power Jl., vol. 48, no. 8, Aug. 1930, pp. 34–41, 8 figs. Description of 15,000-kw. plant of Oklahoma Gas and Electric Co., located near Ponca City in Oklahoma, known as Lincoln Beerbower Station; features use of pulverized pertroleum coke as fuel, 400 lb. pressure and 750 deg. temperature steam, and unusual treatment of unsatisfactory feedwater conditions; list of principal equipment installed in plant is given.

Operation. The Use in Power Stations of Steam Turbines Having, With Their Auxiliaries, Large Overload Capacities, C. A. Parsons, and R. Dowson. World Power (Lond.), vol. 14, no. 80, Aug. 1930, pp. 148–149 and 151–157, 6 figs. Direct comparison is made between cost of generating emergency peak load by (1) turbo-generators with 25 per cent overload capacity, peak load carried by additional plant lying idle during rest of day, and (2) turbo-generators with 75 per cent overload, no additional plant being used for peak. Abstract of paper presented before World Power Conference, June 1930.

Texas. Devils River Steam Station, C. L. Dowell. Elec. Light and Power, vol. 8, no. 2, Feb. 1930, pp. 35–37, 5 figs. General description of steam plant and equipment of Central Power and Light Company, Texas, of 15,000 kw. initial capacity in two units, with an ultimate capacity of 60,000 kw.; general layout of equipment showing site for future extension; cross section of station; intake screen and tunnel at right.

STEAM ENGINES

High-Pressure. Engine Parts for High-Pressure Superheated Steam (Maschinenteile fuer Hochdruckheissdampf), Salingré. V.D.I. Zeit. (Berlin), vol. 74, no. 36, Sept. 6, 1930, pp. 1237–1242, 13 figs. Effect of heat stresses in flange connections and other constructive features of importance for high-pressure engines; valves and valve gear lubrication.

STEAM PIPE LINES

High-Pressure. Study of High-Pressure Steam Pipe Lines (Essai de contribution a l'étude des tuyauteries de vapeur a haute pression), L. Perreau. Arts et Métiers (Paris), no. 117, June 1930, pp. 233–241, 14 figs. Notes on choice of metals to be employed; joints most suitable to give satisfactory operation; internal pressures; temperatures; abrasive action of fluid; initial deformations; effects of dilation fatigue, etc.

STEAM POWER PLANTS

Ash Handling. Various Types of Ash Conveyors Used in British Power Station Practice, E. W. Robey. Combustion, vol. 2, no. 2, Aug. 1930, pp. 38–42, 10 figs. Description of various types of water-sealed and sluice-type ash conveyors and discussion of typical applications; novel development of water-sealed type of conveyor is also described; in this conveyor series of buckets, mounted on rollers and joined by rubber connections, forms continuous moving trough in which water remains at fixed level; no particular advantage of relative movement between any part of conveyor and material being handled which results in notably low maintenance.

Coal Handling. Handling Coal in Modern Power Plants, L. O. Millard. Blast Furnace and Steel Plant, vol. 18, no. 8, Aug. 1930, pp. 1319–1324 and 1334, 12 figs. Discussion of equipment and procedure for preparing coal and conveying it from storage pile to boilers; data on unloading equipment, feed control, coal elevating units, coal distribution to bunkers, stokers, and pulverizers.

Lower Coal Handling Costs for the Small Power Plant, E. J. Patton. Combustion, vol. 2, no. 3, Sept. 1930, pp. 48–50, 5 figs. Discussion of simple mechanical systems of coal handling which will save money and materially improve working conditions; specific applications are described in which silos of barnyard variety are used for coal storage.

Maintaining Service in Coal and Ash Handling. Power, vol. 72, no. 9, Aug. 26, 1930, pp. 325–329, 6 figs. With high-sulphur coal, maintenance costs on various types of coal-handling systems range from 4 to 6 cents per ton; coal-handling maintenance approximates 6 per cent of total plant maintenance; table illustrating maintenance costs in large central station coal-handling systems; ash removal.

The 100 Atmos. Installation of the Super-Power Plant in Mannheim (Die 100 at-Anlage

des Grosskraftwerkes Mannheim). Elektrotechnische Zeit. (Berlin), vol. 51, no. 31, July 31, 1930, pp. 1105–1108, 5 figs. Details of Hanomag and Humboldt boilers of 835 and 716 sq. m. heating surface, respectively, two 5000-kw. turbines of Brown Boveri Co., Mannheim, Germany, and heat diagram of this extension to initial 57,500 kw. plant.

The Billingham Power Plant of Imperial Chemical Industries. Engineering (Lond.), vol. 130, nos. 3367 and 3369, July 25, 1930, pp. 119–121, and Aug. 8, pp. 183–184, 11 figs. July 25: Quantity of steam required for process purposes is double that necessary to generate requisite electrical energy, so that output of boiler plant is three times that of turbines; adequate stand-by plant had to be provided; high-pressure and high-temperature steam, after utilization in high-pressure turbines, can be passed on to process ranges at original temperature and pressure. Aug. 8: Sectional view is given of one of high-pressure turbines; machines are of single-cylinder type with 16 stages.

High-Pressure. The Use of High Pressure and Temperatures in the Generation of Power, G. A. Orrok. Engineering (Lond.), vol. 130, no. 3374, Sept. 12, 1930, p. 339, 2 figs. Curves show that savings due to high pressure and temperature are real, and of considerable magnitude; comparisons between actual records and curves show that losses become much smaller as use factor increases; high-pressure stations of last few years are all within 1000 B.t.u. of possible saving with higher use factors. Paper read before Section G, Brit. Assn.

New York City. Boiler Capacity Doubled Without Increasing Space. Power, vol. 72, no. 10, Sept. 2, 1930, pp. 385–388, 5 figs. New 700,000-lb. unit of New York Steam Corp. installed in room originally allotted for boilers of 325,000-lb. capacity; furnace volume increased; wider economizers installed; auxiliary equipment employed.

STEAM TURBINES

Design. Recent and Possible Future Developments Affecting the Economics of Large Steam Turbine Practice in the United States, G. B. Warren. Gen. Elec. Rev., vol. 33, no. 8, Aug. 1930, pp. 434–443; Sept., pp. 522–527; 28 figs. Aug.: General trend of large steam-turbine development, as it bears on economics of power-plant operation, with particular reference to designs of General Electric Co. Paper presented at World Power Conference, Berlin, June 16–25, 1930. Sept.: Notes on probable immediate future trend; relative economics of present and possible future steam cycles; effect of new cycles upon possible capacity; effect of more efficient cycles upon turbine design; commercial value; turbine efficiency.

Efficiency. The Rational Definition of Steam Turbine Efficiencies, G. Darrieus. Engineering (Lond.), vol. 130, no. 3373, Sept. 5, 1930, pp. 283–285, 4 figs. Rational definition which can be applied without ambiguity to most general case of heat engines, appears possible only when concepts derived from hydraulics are abandoned and replaced by others based on doctrine of available energy; concept of available energy has advantage of providing at every stage estimate, at once exact and immediate, of efficiency of operation, as well as definite estimate of losses.

Inspection. Turbine Outage Reduced by Regular Inspection. Power, vol. 72, no. 9, Aug. 26, 1930, pp. 346–348, 3 figs. Power plants, both industrial and utility, are called upon to deliver service that must be continuous and uninterrupted; such service cannot be rendered if main and auxiliary turbines are neglected to such extent that forced shutdowns occur.

Ljungström. Radial Steam Turbines With Special Regard to Ljungström Turbine (Radialdampfturbinen mit besonderer Berueecksichtigung der Ljungström-Turbine), H. Kirst. Waerme (Berlin), vol. 53, nos. 30, 32, and 33, July 26, 1930, pp. 569–574, Aug. 9, pp. 606–609, and Aug. 16, pp. 623–626, 35 figs. Development of radial turbines; differences and advantages in comparison with axial turbines defects of original design overcome in Ljungström type, which is latest development of radial turbine.

STEEL

Embrittlement. Brittleness-Embrittlement Phenomena in Steels (Sproedigkeitserscheinungen bei Stahl), O. Schwarz. Maschinenbau (Berlin), vol. 9, no. 14, July 17, 1930, pp. 471–474, 9 figs. Discussion of importance of and tests for ductility; behavior of steel at various temperatures, brittleness as result of age, non-aging steel; notes on various other factors affecting ductility and brittleness.

Molybdenum. Molybdenum in High-Speed Steel, S. B. Ritchie. Army Ordnance, vol. 11, no. 61, July-Aug. 1930, pp. 12–19, 12 figs. Investigation as to practicability of eliminating tungsten wholly or in part from high speed steels undertaking at Watertown Arsenal; comparative test of molybdenum steel with tungsten steel; methods of heat treating molybdenum steel; it was determined that there are no difference of manufacture of molybdenum high-speed steel in desired quantities.

Sheet. Use of Sheet for Stressed Structural Parts (Die Verwendung von Blech fuer beanspruchte Konstruktionsteile), R. Kusserow. Metallboerse (Berlin), vol. 20, no. 62, Aug. 2, 1930, pp. 1713–1714. Author refers to frequent use of commercial fine sheet and warns against its indiscriminate use for highly stressed structural parts; remarks are prompted by tests which are being carried out for purpose of substituting fine sheet for hot-rolled strip steel.

STEEL CASTINGS

Foundry Practice. Preliminary Studies of Effect of Deoxidation and Mold Conditions on the Tensile Properties of Carbon Steel Castings, J. V. McCrae and R. L. Dowdell. U. S. Bur. of Standards—Jl. of Research, vol. 5, no. 2, Aug. 1930, pp. 265–277, 2 figs. Foundry practice used in production of test castings; test methods and equipment; effect of varying ordinary foundry conditions; effect of various deoxidizers and deoxidation methods; surface treatment of green sand molds; effect of green control.

Heat Treatment. Effect of Cooling Rate on the Properties of Steel Castings, W. J. Crook, D. J. Martin, and J. W. Halleg. West Machy. World, vol. 21, no. 7, July 1930, pp. 311–314, 8 figs. Experiments and theories of dendritic structure; dendritic structure and its relation to cooling rate; data on physical properties and microphotographs illustrate results.

STOKERS

Traveling Grate. Relation Between Weight and Temperature of Traveling-Grates (Zusammenhang zwischen Gewicht und Temperatur des Wanderrostes), E. Molinder. Archiv fuer Waermewirtschaft (Berlin), vol. 11, no. 9, Sept. 1930, p. 308, 1 fig. Heat volume transmitted to grate surface through flame radiation is almost constant at a certain flame temperature and temperature increase of grate is universely proportional to its weight.

SUPERHEATERS

Heat Transmission in. Heat Transfer in Superheaters (Die Waermeuebertragung in Ueberhitzern), W. Gumz and F. Michel. Feuerungstechnik (Leipzig), vol. 18, nos. 13/14 and 15/16, July 15, 1930, pp. 129–134, and Aug. 15, pp. 152–155, 15 figs. Contribution to calculation and numerical investigation of superheaters; behavior of superheater in operation; influence of load and temperature regulation; operating troubles.

T

TESTING MACHINES

Fatigue. Design of Fatigue Testing Machines (Zur Konstruktion von Dauerpruefmaschinen), W. Spaeth. Zeit. fuer Technische Physik (Leipzig), vol. 11, no. 4, 1930, pp. 115–118, 5 figs. Theory and principles of construction of Spaeth-Losenhausen machine with details of vibrating motors and appratus for torsional fatigue testing.

Tensile. New German Machines for Testing Tensile Strength (Neue deutsche Zerreissmaschinen), M. Moser. Stahl und Eisen (Duesseldorf), vol. 50, no. 31, July 31, 1930, pp. 1086–1088, 5 figs. Critical description of universal testing machine and two special tensile-strength testing machines with special regard to basic improvements.

TIDAL POWER

France. Tidal Power (L'utilisation de l'énergie des marées). Génie Civil (Paris), vol. 96, no. 20, May 17, 1930, pp. 485–486; see also brief translated abstract in Power Engr. (Lond.), vol. 25, no. 293, Aug. 1930, p. 326. Summary of paper by A. Pawlowski together with one by A. Defour concerning latest improvements in cycle for utilization of tidal power; list is given of 80 places where tidal power could be developed on French coast; only one tidal power station is at present under construction, that at Aber Vrach, which should be ready for service in 1933 and is expected to yield 12,000,000 kw-hr. per year.

TOLERANCES

Standardization. New Tolerances of Gages and Their Size Arrangement With Regard to International Standardization (Neue Genauigkeiten der Lehren und ihre Stufung im Himblick auf die Internationale Normung), R. P. Schroeder. Werkstattstechnik (Berlin), vol. 24, nos. 14 and 15, July 15, 1930, pp. 381–384 and Aug. 1, pp. 410–416, 5 figs. Discussion of German system and suggestion for utilizing experiences made with it for international standards; notes on interdependence of gages, development of tolerances, and classification.

TURBO-GENERATORS

Rotors. Turbo-Generator Rotor Shafts, W. Sharp. Engineering (Lond.), vol. 130, no. 3368, Aug. 1, 1930, pp. 127–129, 27 figs. For machines of this description, there are two classes of steel employed, carbon and 3 per cent nickel; in first method ingot, after being cast, is allowed to cool until center is solid when it is removed from mold and charged into furnace; in second method, ingot after casting is allowed to cool as before, and is reheated for blooming purposes; carbon steel provides adequate margin of safety for present-day design and it is not advisable to use more expensive steel which is possibly less reliable.

V

VALVES AND VALVE GEARS

Hydraulic. The Dow Disc-Arm Pivot Valve. Engineering (Lond.), vol. 130, no. 3374, Sept. 12, 1930, pp. 344–345, 5 figs. Type of butterfly valve made in sizes about 6 ft. in diam. by S. Morgan Smith Co., York, Pa., and of that size and below by Coffin Valve Co., Neponset, Mass.; characteristic feature is that of effecting its movement by applying rotating force near edge of disk as opposed to older plan of applying turning moment to spindle.

Manufacture. The Britannia Works, Huddersfield. Engineer (Lond.), vol. 150, nos. 3888 and 3889, July 18, 1930, pp. 58–59 and July 25, pp. 82–84, 26 figs. partly on p. 66 and supp. plate. July 18: Description of works of Hopkinsons, Ltd., manufacturers of valves and steam fittings; metallurgical section comprises research and routine laboratories, test house, and separate foundries for iron, brass, steel, and Platnam; last-named is special, hard, white, non-corrodible alloy used very extensively in valve manufacture when high pressures and temperatures are dealt with. July 25: Widia tool department; nitrogen hardening; Hopkinson oil purifier; critical pressure gage; electrically controlled valves.

VIBRATIONS

Measurement. Practical and Theoretical Study of Instruments for Recording and Determination of Traffic Vibrations (Praktische und Theoretische Untersuchung von Schwingungsmessern zur Aufnahme und Beurteilung von Verkehrserschuetterungen), W. Zeller. Zeit. fuer Bauwesen (Berlin), vol. 80, no. 7, July 1930, pp. 171–184, 18 figs. Classification of vibration recording instruments, their theory, and details of construction, including seismographs, cibrographs, piezoelectric apparatus, etc.; precision of instruments; calibration; development of absolute intensity scale for rating of earthquakes and vibrations.

W

WAGES

Wage-Payment Plans. Incentives Plain and Fancy, A. Langsner. Factory and Indus. Mgmt., vol. 80, no. 3, Sept. 1930, pp. 527–528 and 551, 4 figs. Study of compensation methods and financial incentive plans which show pronounced drift toward bonus in plants investigated as well as marked tendency away from incentive frills of dozen years ago.

WATER COOLING TOWERS

Calculation. Cooling Tower Chart Replaces Tedious Calculations, G. J. Bischof. Diesel Power, vol. 8, no. 9, Sept. 1930, pp. 462–463, 2 figs. Method of calculating jacket-water circulation and size of cooling tower is outlined; specific example of 500-hp. installation is worked out from chart.

WELDING

Spot, Machine for. Electric Spot Welding Machine (Soudeuse électrique par points), L. Lenouvel. Science et Industrie (Paris), vol. 14, no. 199, Aug. 1930, pp. 595–597, 4 figs. Recently developed welding machine of Sciaky type P. P. 330 for automatic regulation is described; notes on principal characteristics, power consumption, power factor, strength of welds, water cooling of electrodes, water consumption, etc.

IN TWO SECTIONS—SECTION TWO

MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers, 29 W. 39th St., New York, N. Y.

Volume 52 November, 1930, Section Two Number 11

What It's All About

MECHANICAL ENGINEERING attempts to capture the changing scene of varied professional interests and to present to its readers a picture of progress drawn in proper perspective. The high lights of technology are shown against the background of the engineer's place in the history of humanity.

Mechanical engineers produce an extensive literature. No one can read it all, and to help the busy reader of MECHANICAL ENGINEERING, this brief supplement to the November issue has been prepared to tell "What it's all about."

Improving the Properties of Wood

WOOD is a material upon which man has relied from the earliest times. It is suitable for an endless variety of purposes, and has many commendable properties. Although it has been supplanted in some cases by other materials—most of them manufactured—that have, for these purposes, more suitable properties, in its natural state wood is still of great importance.

Some years ago it was found that the properties of steel could be altered by proper treatment so as to obtain tough, strong, hard, or elastic material as might be needed. It has even been possible to make it corrosion resistant. Why not try similar tactics with wood? To some extent this has been done. Railroad ties and piles have been treated to retard the inevitable decay and destruction that come from exposure and the ravages of insects. Building materials have been made more resistant to fire. Surfaces exposed to wear have been treated to decrease the effects of abrasion. These are suggestive of what may be accomplished if sufficient research is applied to the problem.

In the November issue of MECHANICAL ENGINEERING, Warren E. Emley, chief of the Organic and Fibrous Materials Department, United States Bureau of Standards, writes on "Products from Fibrous and Granular Wood." The paper was read at the Fifth National Wood Industries Meeting of the A.S.M.E., New York, October 16 and 17. After discussing the uses for sawdust and wood flour and the utilization of wood waste as a filler, Mr. Emley points out that little is really known about the cellulosic material of which wood is composed. He proposes a program of research which, he says, is so ambitious as to require the services of all of the chemists for a generation, but which might be tackled piecemeal with profitable results. The program is:

1 Ascertain what are the chemical compounds existing in wood.

2 Learn how the three elements, carbon, hydrogen, and oxygen, are arranged in each compound; and

3 Learn how to rearrange these elements to produce compounds presently marketable.

As suggestions of how the properties of wood might be changed to advantage, Mr. Emley proposes the following:

Treatment to render wood temporarily plastic so that it may be bent into permanent useful form.

A process for decreasing its density when desirable.

Improvement in impregnation technology with a view to greater permanency.

A means of increasing the structural strength of wood.

More adequate fireproofing.

A commercial method for increasing surface hardness to resist abrasion.

The use of lignin, the cohesive substance of wood, as a glue or binder so that large pieces and shapes may be made of small ones and have the same strength as though made of a single piece.

Obviously there remains plenty of opportunity for those who wish to work in the field of materials improvement.

Mechanization of Agriculture

WHATEVER may or may not have been done for the relief of the farmer, the engineer, at least, has to his credit the mechanization of agriculture. The weary processes of plowing, sowing, cultivating, and harvesting have been made less burdensome because of machinery, and the productiveness of a man in farm labor has been enormously increased. In an article on "The Application of Engineering to the Agricultural Industry," to be found in the November issue of MECHANICAL ENGINEERING, Prof. Henry Giese, of Iowa State College, Ames, Iowa, shows that in the state of Nebraska the primary power per agricultural worker is 4.71 horsepower, while the value of the crops produced by him annually is $910. The figures for the Italian worker are 0.19 horsepower and $45, respectively.

But mechanization is not the only contribution to the farmer's lot that the engineer has made. Besides power-operated farming machinery the engineer has provided general rural electrification, improved buildings and their appointments, better sanitation, and a greater variety of materials of construction and equipment; and in another category he is responsible for land reclamation, irrigation, drainage, soil-erosion control, and other forms of improvement of agricultural lands.

Employee Training

IN URBAN communities a majority of the men and a large number of women are employed in some sort of occupation or profession for which training is necessary. Some, like doctors and lawyers, get this training primarily in colleges and institutions where a conscious effort is

made at a formal education. Others, like artizans and skilled mechanics, pass through various forms of apprenticeship. Clerks find a business school helpful. Some hapless folk just get a job and do as they are told with as much native ability as they possess. But every one, at some time, has to learn the elements and details of his occupation, and the manner of his learning them is an important economic problem.

W. J. Donald, managing director of the American Management Association, New York, writes on "Decentralized Employee Training" in the November issue of MECHANICAL ENGINEERING. Training of employees is an old problem, as Mr. Donald points out, particularly among craftsmen, but the training of commercial employees is relatively new. Many kinds of schools have been set up on the principle that it should be possible to give the training needed by persons planning to enter industrial and commercial establishments. The history of this phase is outlined by Mr. Donald, who shows that in recent years there has been a distinct swinging away from the assumption that the public school can entirely relieve business of its own responsibility in the problem of employee training. Today, says Mr. Donald, business recognizes that eighty to ninety per cent of management is a training job. Employee training is now confined to training for the job, on the job, by supervisors who have been trained to train.

"BLINKER" MOISTURE INDICATOR FOR WOOD

A Moisture Indicator for Wood

AT THE Fifth National Meeting of the A.S.M.E. Wood Industries Division, held in New York, October 16 and 17, there was exhibited the "blinker" moisture indicator for wood which is shown in use in the accompanying illustration. This device was developed at the Forest Products Laboratory of the U. S. Department of Agriculture, Forest Service, Madison, Wis. The instrument, whose indications depend upon the variation with moisture content of the electrical resistance of the wood specimens being tested, is suitable for use on well-conditioned lumber one inch or less in thickness, or on thicker material where no appreciable moisture gradient exists. The indications are said to be accurate within one per cent of moisture content, and the useful working range of the instrument is between 8 and 24 per cent of moisture content. As indicated in the illustration, four electrodes on the hammer-like head of the instrument are driven into the sample of lumber. After the proper adjustments are made, the rapidity of the flashes in a neon tube becomes a measure of the moisture content of the wood. Two instruments have been devised, one to measure the moisture content, and the other for purposes of sorting dry and moist lumber.

What of Aviation?

THE progress of aviation has recently suffered some setbacks. In common with other industries, aviation has been affected by the general business depression; and in spite of numerous spectacular and important technical achievements, the appalling tragedy of the *R-101* has lent force to the protests by opponents of lighter-than-air craft that the United States Government abandon its program of construction of this type of ship. In this state of affairs it is profitable to hear what a well-known designer has to say about trends in aircraft design, and what the first U. S. air-mail pilot has to say about flying.

Robert R. Osborn, of the Curtiss Aeroplane and Motor Company, Garden City, N. Y., the designer of the *Tanager*, the plane that won the only award of the Guggenheim Safe Aircraft Competition, says in a paper presented at a meeting of the A.S.M.E. Aeronautic Division, Chicago, Ill., August 25, 1930, and published in the November issue of MECHANICAL ENGINEERING, that the trend of the future will be toward cheaper airplanes that will sacrifice a small portion of their possible high speed, climb, and ceiling, for safety. They will be stable and controllable, and structurally and aerodynamically safe. The landing speed will be low, within safe and reasonable limits.

Earle Ovington, owner of the Ovington Airport, Santa Barbara, Calif., writes on "Flying From the Private Owner's Standpoint." After discussing such practical subjects as the care of the ship and expense, he takes up some of the changes that must come in order to make private flying safe and attractive, such as visibility, landing speed, stability, noise, cost, and servicing. Until the average man can be given the same carefree transportation in the airplane that he has in the automobile, concludes the first air-mail pilot, it cannot be expected that he will join the ranks of private owners of aircraft.

Fluid Metering

MEASURING fluids in containers presents no very serious difficulties, but measuring them in a state of flow is not so simple. And yet in many practical cases water, steam, air, and many other important fluids must be as carefully measured as is possible. Realizing the importance of this method of measurement and the differences which exist in methods, technique, fundamental data, and even expert opinion, the A.S.M.E. several years ago formed a Fluid Meters Committee. This Committee has issued a commendable report to which revisions are now proposed. In the November issue of MECHANICAL ENGINEERING, Ed S. Smith, Jr., hydraulic engineer of the Builders Iron Foundry, Providence, R. I., presents the portion of his paper on "Quantity-Rate Fluid Meters," read at the World Engineering Congress in Tokyo, 1929, that offers a basis for a proposed revision of Part 1 of the Fluid Meters Committee Report. Discussion of Mr. Smith's paper is earnestly solicited for the benefit of the Fluid Meters Committee.

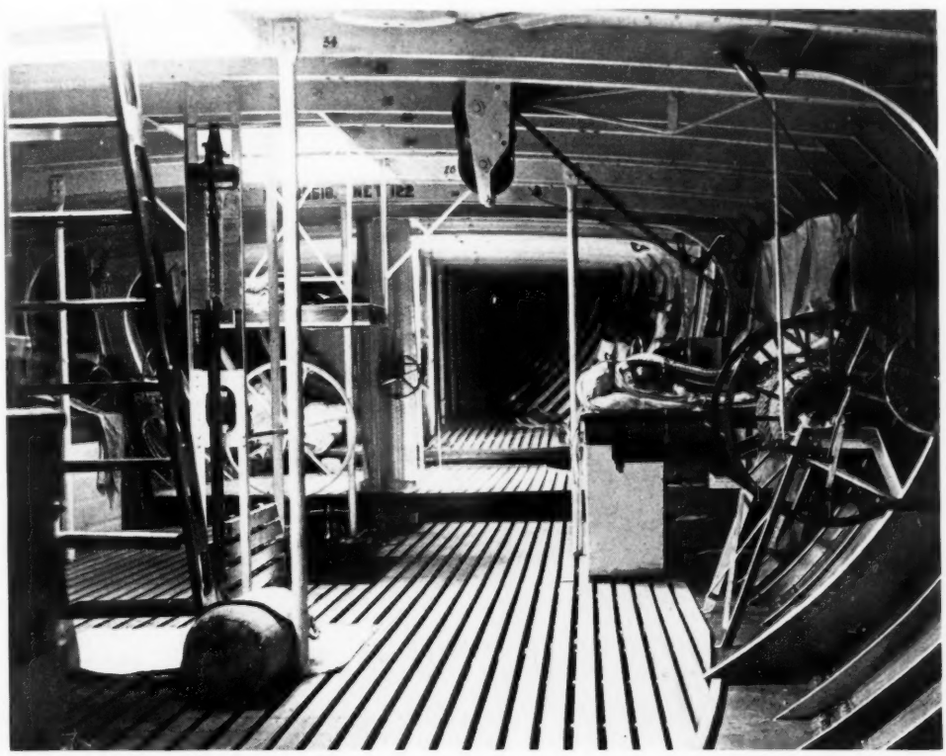
Machine-Tool Milestones

IT HAS frequently been stated that the success of Watt's steam engine depended upon the boring mill which John Wilkinson designed for making the cylinders. Realizing the importance of machine tools, the Machine Tool Builders Association has called them the master tools of industry, for without them it would be impossible to build the production machinery with which factories are equipped. Machine tools combine two admirable characteristics, versatility and precision. They represent an integrity of design and construction so fundamentally sound that they are usually outmoded before they are functionally unfit. With the machine-tool industry are associated the names of some of the most prominent mechanical engineers of the past century.

In writing on "Machine-Tool Milestones, Past and Present," in the November issue of MECHANICAL ENGINEERING, S. Einstein, chief engineer of the Cincinnati Milling Machine Co., shows how in the past each new requirement has brought forth the proper tool to do the work. In the future, he says, the machine tool will be heavier structurally, more rigid, and of greater cutting capacity. With the trend toward higher cutting speeds and the desire for smoother operation will come machines with improved transmission mechanisms. Control will be easier and simpler. There will be an increase in the use of automatic work-holding devices. On the other hand, there may be a replacement of certain machine operations by welding. The paper was read at the French Lick, Ind., Meeting of the A.S.M.E., October 13 to 15.

A New High-Speed Merchant Mill

A NEW mill in the steel industry is always of interest, particularly when it involves such features as are to be found in the Inland Steel Company's high-speed merchant mill at Indiana Harbor, Ind. The mill, which is described in the November issue of MECHANICAL ENGINEERING, was put in operation on August 1 of this year. It is of the purely continuous type, consisting of fifteen stands of rolls, of which Nos. 10, 12, and 14 are vertical. The rolls are motor driven, the motors being located in a separate room, the air of which is artificially cleaned. Shunt-wound direct-current motors drive the rolls, while the beds are driven by alternating-current motors. Provision is made between the stands to prevent the whipping of the loops formed by the difference in speed of the metal leaving one set of rolls and entering the next. The entire operation is controlled by two men in the "pulpit."



SOME MECHANICAL DEVICES ON THE "ENTERPRISE"

This Month's Cover

THE races between the *Shamrock V* and the *Enterprise* had an interest for engineers aside from the sporting character of the event. It is quite obvious, for example, that the designers of these yachts thought of more than the lines of the hull and the character of the sails and rigging. Materials of construction and structural details were given serious engineering study. But while the designer of the *Shamrock V* seems to have been content with steel ribs and a single winch for hoisting the mainsail, the designer of the *Enterprise* made greater use of modern materials and mechanical contrivances to make the most of the advantages they offered, indicating a disposition to let the light of science shine on every feature of the time-

honored problem of propelling a vessel by means of sails.

Instead of the mahogany planking used on the *Shamrock V*, the *Enterprise* had a bronze hull over her steel frame. A strain gage was used to indicate the stresses in the $40,000 duralumin mast of the *Enterprise*. The tension in her stays was not guessed at by the skipper, but measured by means of dynamometers. Numerous winches were used, not only to hoist the sails but to trim them as well. The accompanying photograph shows some of these winches located between decks of the defender.

The principal dimensions of the two yachts are as follows:

	Enterprise	*Shamrock V*
Length, overall	120 ft. 9 in.	119 ft. 10 in.
Length, waterline	80 ft.	81 ft.
Beam, ext.	21 ft. 8 in.	19 ft. 8 in.
Draft, ext.	14 ft. 8 in.	14 ft. 8 in.
Freeboard	5 ft. 4 3/4 in.	5 ft. 5 1/2 in.
Displacement, long tons	128 1/2	134
Sail area, sq. ft.	7583	7540
Total height mast, ft.	168	163
Deck to top sheave, ft.	153	153

Factors of Safety

J. DILOT, of the A. O. Smith Corporation, Milwaukee, Wis., asks, in the November issue of MECHANICAL ENGINEERING, "How Safe Is a Factor of Safety?" Mr. Dilot is chiefly concerned with the application of his question to the case of pressure vessels. He feels that a good deal of mystery has been attached to the "factor of safety," and that it contains a considerable "factor of ignorance." Engineering is rapidly progressing, he concludes, and it seems that we are now on the threshold of an era when uniformly strong pressure vessels can be commercially produced and when there will be no mystery attached to that significant expression, "factor of safety."

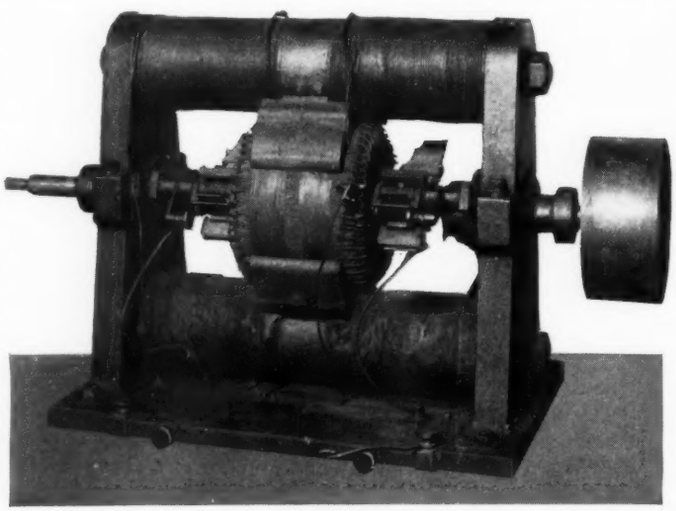
What's New in Engineering?

AN IMPORTANT feature of MECHANICAL ENGINEERING is the "Survey of Engineering Progress," a review of attainment in mechanical engineering and related fields to which about a dozen pages are devoted every month. In the November issue will be found abstracts from important engineering publications representing the entire world, and covering the following topics: Motorless flight; six-years' progress in water-cooled aero engines; fuel problems at American Chemical Society meeting; grinding tests with a simple tube mill; hydraulic characteristics of flow of water around bends; a new type of two-stroke engine; the Junkers aircraft engine; a torque meter for measuring the power output of aircraft engines in flight; methods of securing cool water; a new mud-separator method; chemicals for clarifying and recovering engine condensate; high-pressure boiler-feed systems; a nearly manless boiler plant; cooling and heating with one unit; a 10-in.-pump sand and gravel dredge; removal of oil and grease from metal parts; the tetralin process for cleaning gas pipes; a high-pressure steam engine with opposed pistons; a mean-temperature-difference chart; and the physical properties of hot cement.

Additional evidence of progress is contained in the eight pages of references to current literature supplied by the Engineering Index.

First Dynamo Made in America

IN AN AGE which owes such an abundant debt to electricity, it is always staggering to realize how youthful is this tireless servant of mankind. The accompanying illustration shows the first dynamo made in America. It was constructed at Cornell University in 1875 by Wm. A. Anthony and George S. Moler, professors in the department of physics. It was exhibited at the Centennial Exposition in Philadelphia in 1876, and the engine used to drive this pioneer electric generator was designed by Prof. John E. Sweet, president of the A.S.M.E. in 1884, and constructed by students in the shops of Sibley College, Cornell University.



FIRST DYNAMO MADE IN AMERICA